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MELBOURNE

THE STATISTICAL ANALYSIS OF THE CANADIAN LYNX CYCLE

II. SYNCHRONIZATION AND METEOROLOGY

By P. A. P. MORAN*

[*Manuscript received July* 7, 1953]

Summary

It is shown that trapping figures for the lynx are definitely related to weather conditions. The significance of this for the various theories of the origin and synchronization of the cycle is discussed.

I. INTRODUCTION

In a previous paper (Moran 1953) an attempt was made to analyse the Canadian lynx cycle as a stochastic process. The series of logarithms, x_t, of the number of lynx caught in the Mackenzie River district were shown to be fairly well represented by a random process generated by the relationship

$$x_t - 2.9036 = 1.4101(x_{t-1} - 2.9036) - 0.7734(x_{t-2} - 2.9036) + \epsilon_t, \quad \ldots(1)$$

where ϵ_t is a completely random sequence with zero means and standard deviation 0.2143. This suggests, but does not prove, that some such random oscillatory process is causing the oscillations. Such a process can plausibly be assumed to be due to the intrinsic biological system. The lynx feeds almost exclusively on the snowshoe rabbit, and well-known investigations, e.g. those of Volterra (1931), suggest that in such circumstances oscillations in population density may be expected.

However, this does not explain why the oscillations are so clearly and strongly synchronized over the whole of Canada. We therefore inquire whether meteorological phenomena, for which we would expect a considerable degree of correlation over the whole area, could so influence the population densities as to synchronize the cycles. The random element ϵ_t in (**1**) may well be supposed to have a component due to the effect of meteorological conditions on the birth and death rates. It can easily be shown mathematically that if we have two processes, $\{x_t\}$, $\{y_t\}$, generated by the same relationship of form (**1**) with random elements ϵ_t and η_t, the expected correlation between x_t and y_t will be equal to the correlation between ϵ_t and η_t. Although the author has not calculated the correlations between x_t and the logarithms of the numbers of lynx caught in other regions it is obvious that they must be very high (Elton and Nicholson 1942, Table IV). It follows that if meteorological phenomena cause the synchronization, they must be closely correlated with ϵ_t and there must be a strong correlation between different parts of Canada. However, we do not know in what way such phenomena would affect the population.

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For a complete examination we should presumably have to calculate the multiple correlation coefficients of ϵ_t with both average and extreme temperatures and rainfalls for each month of the year. This is clearly impracticable and we therefore consider only certain selected variables. Hence we cannot expect to find very high correlations.

II. CORRELATION OF CATCH RECORDS WITH METEOROLOGICAL DATA

The above remarks assume that the underlying process is at least approximately of the type generated by equation (1). This implies that if the external shock term, ϵ_t, were removed (i.e. the environment were kept uniform) the oscillations, being damped, would gradually die away. It is quite possible that the relationship between the lynx and the rabbit is of this kind. On the other hand it is quite possible that oscillations would occur even in a constant environment. Such oscillations would have to be represented by non-linear equations and the amplitude of the cycle would be determined by the non-linear terms. This fact has important implications for the synchronization problem.

The correlation coefficients of the residuals calculated from the fitted regression (1) with some of the available meteorological data were therefore found. These residuals were given in a previous paper (Moran 1953). It is important to notice that a test of the significance of these coefficients is quite independent of whether or not the process underlying the observations is of type (1). The effect of calculating correlation coefficients with residuals rather than with the original terms is to remove, as far as possible, the effect of population size in the two previous years and we would hence expect the effect, if any, of the meteorological phenomena to show up more clearly. This is, however, not quite the same as calculating a partial correlation coefficient.

It is well known that the ordinary test of significance for a correlation coefficient between two series does not hold if *both* series are serially dependent. In the present study the meteorological series are almost certainly not serially dependent although the author has not actually tested this. In any case the series of residuals should behave sufficiently as a series of completely independent terms to validate the test.

The meteorological series used were taken from the "World Weather Records" (Smithson. Misc. Coll., vols. 79 (1927) and 90 (1934)). Three stations were chosen:

Edmonton, lat. 53° 35′ N., long. 113° 30′ W.
Barkerville, lat. 53° 2′ N., long. 121° 35′ W.
Winnipeg, lat. 49° 53′ N., long. 97° 7′ W.

Barkerville appeared to be the closest station with a sufficiently long series of observations. The area implied by the term 'Mackenzie River District' changed somewhat during the period considered (1821-1934), as is shown in the maps given by Elton and Nicholson (1942), but it is thought that this had little effect on the series. Edmonton was chosen because it was fairly near the area studied and had a somewhat longer series of observations than Barkerville. Winnipeg, on the other hand, was chosen because it was very distant. The seven series used are as follows and relate to temperature alone:

A_t.—The minima of the average monthly temperatures at Edmonton for December, January, and February of the winter $(t-1,t)$. 48 observations, 1883-1930.

B_t.—The sum of the average monthly temperatures at Edmonton for July, August, and September of the year t. 48 observations, 1883-1930.

C_t.—The minima of the average monthly temperatures at Winnipeg for December, January, and February of the winter $(t-1,t)$. 48 observations, 1883-1930.

TABLE 1

CORRELATION COEFFICIENTS OF TEMPERATURE SERIES ($A_t, \ldots, G_t$) WITH RESIDUALS OF ANNUAL LYNX CATCHES IN YEARS $t-1$, t, AND $t+1$

Temperature Series	R_{t-1}	R_t	R_{t+1}
Edmonton A_t (48)	$-0{\cdot}151$	$-0{\cdot}087$	$+0{\cdot}394$**
B_t (48)		$-0{\cdot}077$	$+0{\cdot}174$
Winnipeg C_t (48)	$-0{\cdot}050$	$+0{\cdot}044$	$+0{\cdot}338$*
D_t (48)		$+0{\cdot}001$	$+0{\cdot}027$
Barkerville E_t (41)	$-0{\cdot}120$	$-0{\cdot}234$	$+0{\cdot}247$
F_t (40)		$-0{\cdot}162$	$+0{\cdot}068$
G_t (40)		$-0{\cdot}386$*	$+0{\cdot}063$

* Significant at 5 per cent. level.

** Significant at 1 per cent. level.

D_t.—The sum of the average monthly temperatures at Winnipeg for July, August, and September of the year t. 48 observations, 1883-1930.

E_t.—The minima of the average monthly temperatures at Barkerville for December, January, and February of the winter $(t-1,t)$. 41 observations, 1888-1906, and 1908-1929.

F_t.—The sum of the average monthly temperatures at Barkerville for May and June of the year t. 40 observations, 1888-1906 and 1908-1928.

G_t.—The sum of the average monthly temperatures at Barkerville for July, August, and September of the year t. 40 observations, 1888-1906 and 1907-1928.

The series of residuals used, which we denote by R_t, are given in the previous paper (Moran 1953) and are equal to

$$x_t - 2.9036 - 1.4101(x_{t-1} - 2.9036) + 0.7734(x_{t-2} - 2.9036),$$

where x_t is the logarithm of the number of lynx caught in the 'outfit' of the year t, i.e. caught during the period July 1 of year t to June 30 of year $t+1$. R_t thus represents in some degree the amount of the increase in population density in the trapping period $(t, t+1)$ when the effects of the population size in the two previous periods have been removed. The correlation coefficients of the series $A_t, \ldots, G_t$ were found with R_t and R_{t-1} and also the correlation of R_{t-1} with A_t, C_t, and E_t. These are shown in Table 1. The numbers of observations are shown in brackets.

The meaning of these coefficients may be illustrated by considering the first line; -0.151 is the correlation between the residuals corresponding to outfit t and the minimum winter temperature at Edmonton during the period corresponding to t, i.e. July 1 of year t to June 30 of year $t+1$. This is the period during which trapping took place. Similarly -0.087 is the correlation of R_t with the minimum winter temperature of the *previous* outfit and 0.394 is the correlation with the minimum temperature of the outfit before that.

It is clear that we can apply the ordinary tests of significance to these coefficients. The 5 and 1 per cent. two-sided significance levels for a single r and 48, 41, and 40 pairs of observations are shown in Table 2.

TABLE 2

SIGNIFICANCE LEVELS OF $r(\rho = 0)$

n	5%	1%
48	0·284	0·368
41	0·308	0·398
40	0·312	0·403

The coefficients in Table 1 which are individually significant at the 5 and 1 per cent. levels are indicated. We have to be careful in ascribing reality to significant coefficients where, as at present, we have calculated a number of coefficients. However, it seems clear that the sequence of residuals is not independent of the meteorological series. The implications of this fact require careful consideration.

The correlations which we therefore take as significant are those of R_t with:

(1) The mean temperature for July, August, and September at Barkerville during the period of the previous outfit (-0.386). The values for Edmonton (-0.077) and Winnipeg (-0.001) are very small.

(2) The minimum temperatures in December, January, and February of the outfit $t-2$ (0.394 at Edmonton, 0.338 at Winnipeg, and 0.247 at Barkerville).

Lynx apparently mate in January and February and the young are born in March or April, the gestation period being about 60 days, and there are four or five young in a litter (Burt 1946; Rand 1948). These figures are worth considering in relation to the trapping numbers given in Elton and Nicholson (1942, Table IV). If there is only one litter and no deaths at all during the year the population's maximum rate of increase will be given by a ratio $1 + \frac{1}{2}(4) = 3$, or $1 + \frac{1}{2}(5) = 3.5$, of one year's population to the previous one. If the trapping figures in Table IV of Elton and Nicholson's paper really are proportional to the actual population size it would seem that those ratios are occasionally attained or even exceeded. We can neglect the figures for small catches, but for values over 1000 statistical errors should not be large. Consider as an example the figures in Table 3.

Taking into account the fact that some animals must die even in the best years, the observed ratios in Table 3 are remarkably high. Three possible explanations suggest themselves:

(1) The trapping figures are not good estimates of the true population densities because of sampling or other random errors. If this is true we must have a considerable error term superimposed on the underlying random process and this will deflate the serial correlations of x_t. This does not seem consistent with the very high values observed, e.g. $r_1 = 0.795$.

(2) The trapping figures are closely related to the actual population density, but in a non-linear fashion, so that trapping efficiency increases for large population densities. While this may be true for very small densities it seems unlikely for densities of size corresponding to the trapping figures of Table 3.

(3) More than one litter is produced during a year when conditions are exceptionally favourable. From the figures alone this looks the most plausible explanation but Elton states (personal communication) that it is biologically very unlikely. He suggests that migration from one district to another may be important but examination of figures for neighbouring districts such as those given in Table 3 seems to make this unlikely.

TABLE 3

INCREASE OF LYNX POPULATIONS IN SUCCESSIVE YEARS

Region	1865	1866	Ratio	1883	1884	Ratio
Mackenzie River	3311	6721	2·03	2042	2811	1·38
Athabasca Basin	3511	1756	0·50	5736	12882	2·24
West Central	6138	12584	2·05	3015	9580	3·18
Upper Saskatchewan	4185	14671	3·50	1161	6336	5·45
Winnipeg Basin	9743	21096	2·17	3587	10331	2·87

III. DISCUSSION

Now consider in what ways the weather might affect the population size. It might act directly by affecting the death rate. Thus we might expect R_t to be positively correlated with the minimum winter temperature during the outfit t or perhaps $t-1$. This is not observed. Alternatively it might be the birth rate which is affected. It is not known at what age the lynx begin to be trapped but if it is the birth rate which is affected we would expect R_t to be positively correlated with the minimum winter temperature during the outfit $t-1$ or $t-2$. In fact it is only with $t-2$ that significant values are observed. Alternatively the weather may act directly on the rabbit population or indirectly by affecting the vegetation. This would also imply a lag like the one observed and would also suggest that summer weather plays a part. Under normal circumstances the sole food of the lynx is the snowshoe rabbit, which feeds on vegetation and is therefore presumably very dependent on weather.

We have, however, to consider the important question as to whether the observed correlations might be due to the effect of weather on the trappers and the trapping efficiency rather than on the animal population. Elton states (personal communication) that some such effect may be expected and that, for example, very heavy snowfalls must hinder trapping. In the present and previous paper we have assumed that the number trapped, y_t, can be regarded as a fairly accurate estimate either of the actual population multiplied by a constant or, if trapping efficiency varies with population density, of some definite function of the total population, so that we can write

$$y_t = a f(N_t),$$

where N_t is the total population. If a varies from year to year so that we write it a_t we have

$$x_t = \log a_t + \log f(N_t).$$

If we now suppose a_t not to be serially correlated, since it is presumably dependent only on the weather and other serially random influences, the quantity $\log a_t$ plays the part of a random error superimposed on the random process $\{\log f(N_t)\}$. Thus if it is the trapping efficiency rather than the population which is influenced by weather two conclusions may be drawn:

(1) There will be a strong positive correlation between the residuals for each outfit and the minimum temperature in December, January, and February of the same outfit. This is not observed, the correlations being small and negative (-0.151 for Edmonton, -0.05 for Winnipeg, and -0.12 for Barkerville). Thus the effect of heavy snowfalls mentioned by Elton does not show up in these figures.

(2) The serial correlation coefficients of the series x_t will be deflated below what they would otherwise have been. In fact $r_1 = 0.795$, which is large, and the general shape of the correlogram suggests that this is not so.

It therefore seems clear that the effect of the weather is directly or indirectly on the lynx population and not on the trapping efficiency. The correlation with the minimum winter temperatures of the outfit 2 yr before (0.394 for Edmonton, 0.338 for Winnipeg, and 0.247 for Barkerville) might be due either to the direct effect of the weather on the birth rate at that time, the young not being trapped until 21 months later; or to the effect on the rabbit population, thus reducing the future food supply of the lynx. The correlation with the mean summer temperature at Barkerville (-0.386) is not so easy to explain. Trapping does not take place at this time. It is possible that the effect, if real, is on the vegetation and thus on the rabbit.

If then we regard it as proven that the weather influences the lynx cycle, can this be the explanation of the synchronization of cycle over the whole of Canada? That such a synchronization exists is quite clear from an examination of the records (Elton and Nicholson 1942, Table IV). No attempt has been made to calculate the correlation coefficients between the series for different trapping regions but the close synchronization of the peaks and troughs shows that they must be high.

Suppose that the logarithms of the trapping numbers in two different regions can be represented by processes defined by the relations

$$x_t = ax_{t-1} + bx_{t-2} + \epsilon_t,$$
$$z_t = az_{t-1} + bz_{t-2} + \eta_t,$$

so that the structures of the processes are the same but the random elements, ϵ_t, η_t, are different but correlated, then it is easy to show that the correlation between x_t and z_t will be equal to that between ϵ_t and η_t. (If the autoregression coefficients are different in the two processes, this result no longer holds exactly.) Now if ϵ_t and η_t are closely correlated with the local meteorological conditions, and the latter in the two regions are correlated, we have a possible explanation for the correlation between the observed records.

As an illustration of the correlation between weather conditions at different places the correlation coefficient between the series A_t and C_t (minimum winter temperatures at Edmonton and Winnipeg) was calculated and found to be 0.681. This is fairly high and certainly significant, but from Table 1 it is clear that the observed correlations with the particular meteorological series chosen are not high enough to account for the correlation between the trapping records. This, however, is scarcely to be expected. What would be relevant is the multiple correlation coefficient between the residuals and *all* the meteorological factors affecting the population. The calculation of such a correlation coefficient would be a very large undertaking and would leave many fewer degrees of freedom for testing its significance. All we can say therefore is that the observed correlation coefficients are consistent with, and suggestive of, the idea that weather is the synchronizing agency, and that the populations concerned are definitely dependent on some of the meteorological factors. It should also be pointed out that we have omitted consideration of precipitation. Some authors believe (Rowan 1950) that this may be an important factor because of its effect on the river levels.

If on the other hand the underlying process is non-linear, and the cycles would occur in a uniform environment, it is possible that a lower correlation between the residuals in different places might still produce a high probability of synchronization, in much the same way as a weak regular electrical oscillation will synchronize a highly non-linear electrical oscillator such as a multivibrator. The mathematical implications of such a non-linear situation would be very much more difficult to investigate.

So far then our findings are consistent with the view that the cause of the cycle is the predator-prey relationship of the lynx and the rabbit and that the synchronization is due to weather. Some difficulties about this theory need stating. Firstly, it is known that other animals, including fish, cycle in unison with the lynx (see Rowan 1950). It is difficult to see how these animals are ecologically dependent on the lynx or rabbit. Moreover, Elton and Nicholson (1942) state that they have evidence that rabbits introduced onto Anticosti I. cycle with the mainland population although no lynx are present. If this is true, it is very hard to reconcile with the above theory (Hutchinson and Deevey 1949). Thus it is hard to study the whole series of trapping records without feeling that there is some very powerful external influence at work. On the other hand solar activity, as indicated by sunspot numbers, is definitely not related to the lynx cycle (Moran 1949) and no other natural phenomenon seems to provide an explanation.

IV. ACKNOWLEDGMENTS

I am much indebted to Mr. C. Elton, F.R.S., for some helpful criticism, and to Miss J. Duffield for carrying out the calculations.

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THE OCCURRENCE AND SIGNIFICANCE OF THE PERITROPHIC MEMBRANE, WITH SPECIAL REFERENCE TO ADULT LEPIDOPTERA AND DIPTERA

By D. F. Waterhouse*

[*Manuscript received June* 30, 1953]

Summary

Adults of a number of lepidopterous families and most adult cyclorrhaphous Diptera possess a tubular chitinous peritrophic membrane arising at the level of the oesophageal invagination.

Membranes containing chitin, and produced by the general midgut epithelium, are present in adults of some other families of Lepidoptera and in some nematocerous and orthorrhaphous Diptera. In some species of these latter groups (e.g. the blood-sucking females of mosquitoes and tabanids) membranes appear to be mainly formed following ingestion of food and are produced by a restricted region of the general midgut epithelium. Chitin-containing membranes enveloping the food are present also in Thysanura, Embioptera, Mallophaga, Coleoptera (Dermestidae and Carabidae), Mecoptera, and Hymenoptera (some Formicidae).

It has been established that the midgut epithelium is able to secrete a chitinous membrane. It is probable that the ancestral insect midgut epithelium possessed the capacity to secrete chitinous membranes enveloping the food. This capacity has been lost in some insects and in others it has been restricted to a particular zone of the midgut. It is possible that the well-defined tubular membranes are the result of the restriction of this capacity to the extreme anterior end of the midgut.

I. Introduction

The food in the midgut of many insects is enclosed within a single or multilayered sheath known as the peritrophic membrane. It is generally believed that this membrane is formed in two distinct ways. In the first method (many Diptera, Dermaptera, and some other insects) it is a tough tube consisting of one, two, or more layers, which is produced mainly or entirely by a ring of cells at the anterior end of the midgut (type I). In the second method (many other insects) it consists typically of a series of thinner, coaxial layers and arises by periodic delamination from the surface of the striated border of a layer of material secreted from the whole midgut epithelium (type II). In some species producing the sheath by the second method it appears that the secretion is formed by a restricted zone (e.g. the posterior portion) of the midgut epithelium, although such sheaths have not been generally regarded as constituting true peritrophic membranes. The majority of authors have been protagonists of one or the other method of formation, often denying the possibility of an alternative method. The two methods of formation are not mutually

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exclusive, for in some insects, e.g. the honey-bee, the multilayered membrane is formed of layers produced by both methods (Wigglesworth 1930; von Dehn 1933; Aubertot 1934).

A well-developed and often complex oesophageal invagination is characteristic of insects which produce a type I peritrophic membrane, although this occurs also in groups in which no membrane has been recorded and in insects which produce only type II membranes. However, a poorly developed invagination is possessed by most insects producing type II membranes.

The thin multilayered type II membranes of *Carausius, Periplaneta, Locusta, Tenebrio, Galleria, Peridroma,* and *Tineola* (Martignoni 1951; Mercer and Day 1952), which have been examined with the electron microscope, all exhibit a somewhat similar 'fish-net' structure. On the other hand the fine structure of membranes formed by the first method is not yet known, the unaltered membrane (e.g. from an adult blowfly) being too dense or thick for the electron beam to penetrate. However, treatment of this membrane with pepsin or alkali resulted in an intact membrane with rather irregular reticulations of the same general order of size as the 'fish-net' of the type II membranes (Richards and Korda 1948).

Doubt has been expressed that the membranes produced by the two methods are really homologous (rather than analogous), although they are both composed of chitin and probably protein and both presumably have the same function. The main function of the peritrophic membrane is thought to be the protection of the midgut epithelium from damage by hard or sharp particles of food, thereby performing the function of the mucus of mammals, a material which is absent from the lumen of the insect midgut (Wigglesworth 1948; Day 1949).

There are very few records of the absence of a peritrophic membrane in insects ingesting hard or sharp particles of food. However, it is, for example, said to be absent in *Gryllotalpa* (Cuénot 1895), in larvae of the carpet beetle *Anthrenus* (Mobusz 1897), in adult ants (Loele 1914, von Dehn 1933), and in larvae and adults of *Panorpa* (Grell 1938). In *Gryllotalpa* long plate-like extensions of the oesophageal invagination (foregut) extend into the hindgut and prevent the food from coming into direct contact with the midgut epithelium.

On the other hand, most authors have reported the absence of a peritrophic membrane in insects belonging to certain orders which ingest only fluids throughout their entire life, such as Anoplura, Thysanoptera, and Hemiptera. The one recorded exception in the Hemiptera is the recently reported presence of a delaminated chitin-containing membrane in Corixidae (Sutton 1951).

A peritrophic membrane is reputedly absent also from the fluid-feeding adults of several groups which possess it regularly in the larval stage. Thus, in adult Diptera it is often held to be missing in the Nematocera and in orthorrhaphous families of the Brachycera, although it is present in all cyclorrhaphous families examined.

A peritrophic membrane is said to be lacking also in both Carabidae and Dytiscidae (Rungius 1911; Wigglesworth 1930; Bess 1935), where extra-gut digestion reputedly occurs, although a peritrophic sheath has been recorded in

Carabidae and Dytiscidae by Aubertot (1934); in adult Ephemeroptera (von Dehn 1933), which do not consume food; and in adult Siphonaptera (Faasch 1935).

It is often stated in textbooks and in the literature that a peritrophic membrane is entirely absent in all adult Lepidoptera (e.g. Bordas 1905, 1920; Stober 1927; Wigglesworth 1950). Since adult Lepidoptera feed only on liquids, if at all, this statement agrees well with its absence in so many other fluid feeders. Its presence in lepidopterous larvae is, however, well established (e.g. Bordas 1911; Henson 1931; Wigglesworth 1930). There are two isolated records of its presence in adult Lepidoptera of the genus *Pieris*. The first is the reference by E. Petersen (1912) to a statement by W. Petersen that a membrane was observed in the midgut of *P. rapae*, although the former could not confirm this. The second is for *P. brassicae* L. (Aubertot 1934). At first sight these records appeared to constitute just another of the numerous contradictions in the extensive and confusing literature on the occurrence and formation of the peritrophic membrane.

It is highly probable that the confusion in the literature does not arise from a completely haphazard occurrence of quite distinct types of peritrophic membrane. It should be possible to formulate generalizations concerning its occurrence if the true facts are available. Important questions are:

Is a peritrophic membrane generally absent from fluid-feeding insects, or is there no necessary correlation with type of food? Is a peritrophic membrane absent (as reported in the literature) from some groups of insects feeding on solid foods? Does the endodermal midgut secrete a chitinous peritrophic membrane in some insects? Is the peritrophic membrane formed in some insects only in response to feeding? Are there two quite distinct types of peritrophic membrane, one produced by ectodermal and the other by endodermal cells, or are these modifications of the same process?

Answers were sought to these questions, using a range of insects feeding on solids or fluids and employing a micro-adaption of van Wisselingh's test for chitin (Campbell 1929), which enables this characteristic component to be detected in fine fragments of membrane. The data obtained now permit a number of generalizations which are dealt with in the discussion.

II. Methods

The presence or absence of a peritrophic membrane was determined primarily by dissection of the living midgut, which had previously been freed from other tissues. With the mirror of the dissecting microscope adjusted to provide somewhat oblique illumination, an incision was made in the midgut immersed in saline. When a type I peritrophic membrane was present a loop of membrane generally protruded immediately from the incision. This loop was often more readily seen if the adults were fed before dissection on coloured sugar solution. In most species there was seldom any doubt as to the presence or absence of this type of membrane. Where doubt existed, as when a type II membrane was found in a restricted region of the midgut, a peritrophic membrane was regarded as being present when a definite single or multilayered sheath enclosed the food, provided it gave a positive test for chitin.

To detect chitin, van Wisselingh's test was employed, using a small pressure container made from stainless steel (Fig. 1). The membrane was placed in a drop of saturated aqueous KOH in the shallow glass boat (*A*). After heating at 155°C in a thermostatically controlled oven for ½-3 hr, the glass boat was transferred to an excavated block and examined under the microscope for the presence of undissolved fragments. When present these were recovered for subsequent testing with iodine by gently flooding the block and the boat with 90 per cent. alcohol. By not moving fragments across a liquid-air interface, very delicate membranes could be handled with comparative ease. The moat (*B*) containing KOH solution was of value only when the membranes were heated for long periods, when any minor gasket leak becomes important. Under these conditions the relatively large surface area of the moat KOH helped to slow down the rate of evaporation from the drop of KOH in the boat. For short heating periods a container without a moat would be satisfactory.

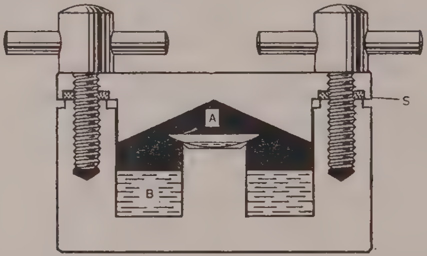


Fig. 1.—Pressure container for chitin test. *A*, small transparent glass boat; *B*, moat for KOH; *S*, gasket.

On several occasions the carefully washed membranes were heated in 50 per cent. aqueous glycerine to which a few crystals of ninhydrin had been added. A positive test indicated the possible presence of protein.

For histological examination, alimentary canals were fixed in alcoholic Bouin and stained in Mallory's triple connective-tissue stain or by Bodian's protargol method. Absence of a membrane in sections was not, however, regarded as proof that the species concerned did not produce peritrophic membrane.

Most of the individuals used were caught as adults, although some species were reared from larvae or pupae.

III. Results

(*a*) *Adult Butterflies*

Adults of 58 species of butterflies belonging to seven families were dissected and occurrences of a peritrophic membrane recorded (Table 1). A type I peritrophic membrane was absent in all representatives of the Hesperiidae (15), Satyridae (11), and Nymphalidae (4), whereas it was present in the Danaidae (2), Papilionidae (4), Pieridae (6), and Lycaenidae (16) (Table 1). Although some families are represented by relatively few species, the type I membrane was so distinct if present that it is believed that the data can be used as a basis for generalizations. In *Danaida plexippus*, for example, it was a tough tubular structure of considerable mechanical strength which, like other membranes tested from this group of families, gave positive tests for

TABLE 1

OCCURRENCE OF A TYPE I PERITROPHIC MEMBRANE IN ADULT BUTTERFLIES

Trinomial nomenclature used only where the type race of the species was not investigated

Absent	Present
Hesperiidae	Danaidae
Netrocoryne repanda Feld.	*Danaida plexippus* (L.)
Trapezites symmomus Hubn.	*D. chrysippus petilia* (Stoll.)
T. eliena (Hew.)	
T. maheta praxedes (Plotz)	Papilionidae
Signeta flammeata (Butl.)	*Papilio sarpedon choredon* Feld.
Mesodina halyzia (Hew.)	*P. macleayanus* (Leach)
Toxidia peroni (Latr.)	*P. aegeus* Don.
Dispar compacta (Butl.)	*P. anactus* Mach.
Hesperilla ornata (Leach)	
Padraona flavovittata (Latr.)	Pieridae
P. lascivia (Rosenstock)	*Pieris rapae* (L.)
P. hypomeloma (Low.)	*Anaphaeis java teutonia* Fabr.
Taractocera papyria (Bois.)	*Terias smilax* (Don.)
Astycus kreffti ancilla (H.-S.)	*Delias nigrina* (Fabr.)
Cephrenes augiades sperthias (Feld.)	*D. harpalyce* (Don.)
	D. aganippe (Don.)
Satyridae	
Heteronympha merope (Fabr.)	Lycaenidae
H. banksi (Leach)	*Zizeeria labradus* (God.)
H. philerope (Bois.)	*Lucia limbaria* Swainson
Tisiphone abeona (Don.)	*Lampides boeticus damoetes* (Fabr.)
Hypocysta pseudirius Butl.	*Candalides acasta* Cox
H. adiante (Hubn.)	*C. hyancinthina* Semper
H. metirius Butl.	*C. xanthospilos* Hub.
Yphthima arcotus (Fabr.)	*C. consimilis* Waterh.
Xenica klugi (Guér.)	*Neolucia agricola* Westw.
X. acantha (Don.)	*N. mathewi* Misk.
Oreixenica lathoniella herceus Waterh. & Lyell.	*N. serpentata* H.-S.
	Nacaduba felderi (Murray)
Nymphalidae	*N. biocellata* Felder
Precis villida calybe God.	*Orgyris ianthis* Waterh.
Pyrameis cardui kershawi McCoy	*Ialmenus evagoras* (Don.)
P. itea Fabr.	*Hypochrysops ignita* Leach
Eriboea pyrrhus sempronius Fabr.	*Pseudodipsas brisbanensis* Miskin

chitin and protein. A positive ninhydrin test for protein was still given by the carefully washed membrane after incubation for 24 hr in buffered trypsin or papain.

The only exceptions in the group of families possessing a type I peritrophic membrane were two freshly emerged, unfed specimens of *Anaphaeis java* (Pieridae) and *Lampides boeticus* (Lycaenidae) in which a peritrophic membrane was not observed, although it was found in numerous older adults. A possible explanation (if indeed it was absent) is that in some adult butterflies the peritrophic membrane may first be produced after emergence, and perhaps only in response to feeding (cf. Wigglesworth's (1929) observations on *Glossina*). However, a type I membrane can be clearly seen in *Pieris rapae* pupae dissected a couple of days prior to emergence.

In species producing a type I membrane this originates from a mass of deeply staining cells lining the inner wall of the oesophageal invagination (Plate 1, Figs. 1 and 2). The peritrophic membrane appears to stream off the posterior end of this cell mass. In transverse sections it often appears to have a smaller diameter than the midgut (Plate 1, Fig. 3).

In the three families lacking a type I peritrophic membrane a softer, less well defined, and more fragile membrane containing chitin frequently surrounds the contents of the posterior midgut (species such as *Trapezites symmomus* and *Mesodina halyzia* (Hesperiidae), *Heteronympha merope* (Plate 1, Fig. 4), *H. banksi,* and *H. philerope* (Satyridae), and *Pyrameis kershawi* and *Precis villida* (Nymphalidae)). In some species these type II membranes were observed in all specimens examined; in other species they could be seen only in a proportion of individuals; and in yet other species no membrane was detected in the few specimens available. As one example, a membrane could only be detected (in the posterior fifth of the midgut) in 13 specimens out of 25 freshly caught *P. kershawi.* In a further test with this species, nine adults were fed for 3 days on dyed 10 per cent. sugar solution before dissection. A peritrophic membrane was observed in four individuals. This indicates that a recognizable membrane is not present continuously even when food is readily available.

(*b*) *Adult Moths*

Some 10,000 species of moths belonging to more than 70 families have been described from Australia. In a brief survey of this vast fauna some 100 species belonging to 32 families were examined. Most of these were caught in the field, many species being represented by one or two specimens only, although five to 10 individuals of some species were dissected. In most instances no precautions were taken to ensure what are believed to be favourable conditions for the detection of the peritrophic membrane, namely, only dissecting individuals which had taken food recently. Further, in relatively few instances was the chitin test applied to the membranes observed. It is clear therefore that the records must be regarded as preliminary.

A type I peritrophic membrane is recorded as occurring in all representatives of six families (Plate 1, Figs. 5, 6, and 7), and in some representatives of a further four families (Table 2). In approx. 75 per cent. of the species examined, however, a type I peritrophic membrane could not be detected, although it is considered that a type II membrane would be observed in many of these species on careful examination of adequate numbers of specimens. The type I peritrophic membrane of moths is generally a less well-defined structure than that of butterflies and has less resistance to mechanical damage. In some families, of which only a single recently emerged specimen of a species was available, it was difficult to decide whether a cylindrical mass of semi-solid material was food enclosed in a type II membrane or the so-called 'yellow body.' Lotmar (1942), for example, has shown that in the midgut of newly emerged *Tineola bisselliella* (Humm.) (clothes moth) adults there are still traces of both larval and pupal midgut epithelia, so that fragments of larval peritrophic membrane may be present. These residues, which form the 'yellow body,' occur in many insects and are discharged at varying times after emergence.

TABLE 2

OCCURRENCE OF A TYPE I PERITROPHIC MEMBRANE (P.M.) IN ADULT MOTHS

+, Membrane observed; —, no type I membrane observed. The numbers in brackets indicate the numbers of species* of each family investigated

Family, etc.		P.M.	Family, etc.		P.M.
HOMONEURA			Zygaenoidea	Zygaenidae (2)	+
Hepialoidea	Hepialidae (3)	—	Cossoidea	Cossidae (1)	—
HETERONEURA			Lasiocampoidea	Lasiocampidae (1)	+
Gelechiodidea	Oecophoridae (10)	—	Noctuoidea	Anthelidae (2)	—
	Gelechiidae (2)	—		Agaristidae (2)	—
	Gelechiidae (2)	+		Noctuidae (14)	—
	Xyloryctidae (1)	—		Nolidae (2)	—
	Xyloryctidae (1)	+		Hypsidae (1)	—
Tortricoidea	Eucosmidae (2)	+		Arctiidae (4)	—
	Tortricidae (6)	+	Sphingoidea	Sphingidae (1)	—
Tineoidea	Plutellidae (1)	—	Geometroidea	Oenochromidae (7)	—
	Lyonetiidae (1)	—		Oenochromidae (1)	+
	Tineidae (1)	—		Boarmiidae (2)	—
Pterophoroidea	Pterophoridae (3)	—		Boarmiidae (4)	+
Pyraloidea	Oxychirotidae (1)	—		Geometridae (1)	+
	Phycitidae (3)	—		Sterrhidae (2)	—
	Crambidae (1)	—		Larentiidae (8)	+
	Pyralidae (1)	—	Bombycoidea	Saturniidae (1)	—
	Pyraustidae (7)	—		Bombycidae (1)	—

* A list of species investigated is available from the Librarian, Division of Entomology, C.S.I.R.O., Canberra.

In spite of these many reservations there is no doubt that a type I membrane occurs regularly in some families (e.g. Tortricidae and Larentiidae), and that a type II membrane is present in many other families.

In some species of Lepidoptera producing a type I membrane it appears that the general midgut epithelium also contributes to the thickness of the sheath at lower levels in the midgut.

(*c*) *Adult Diptera*

As pointed out earlier, a type I peritrophic membrane arising at the level of the oesophageal invagination appears to be lacking in adult Nematocera and in orthorraphous families of the Brachycera, although it has been recorded in all cyclorrhaphous families examined. This picture has been broadly confirmed in the present study (Table 3). Three exceptions, however, should be noted.

TABLE 3

OCCURRENCE OF A PERITROPHIC MEMBRANE (P.M.) IN SOME ADULT DIPTERA

Where the family name only is given unidentified representatives were examined. — = No membrane detected

Family, etc.	P.M.
NEMATOCERA	
Tipulidae	II
Rhyphidae	
Rhyphus dubius Macq.	—
Culicidae	
Aedes aegypti (L.)	II
Culex fatigans (Wied.)	II
Bibionidae	II
BRACHYCERA	
ORTHORRHAPHA	
Tabanidae	
Dasybasis froggatti (Ric.)	II
Scaptia jacksoniensis (Guér.)	II
Scaptia guttata (Don.)	II
Stratiomyiidae	
Neoexaereta spiniger Wied.	II
Nemestrinidae	
Tricophthalma bivittata (Westw.)	—
Therevidae	
Frontissa argentea Par. (*in litt.*)	II
Asilidae	
Brachyrrhopala sp.	—
Thereutria amaraca Walk.	II
Mydaidae	
Diochlistus gracilis Macq.	II
Apioceridae	
Apiocera maritima Hardy	II
Bombyliidae	
Systoechus sp.	II
Comptosia quadripennis Walk.	II
Villa alterna Macl.	II
V. fuscicostata Macl.	II
Dolichopodidae	II
CYCLORRHAPHA	
Syrphidae	
Syrphus sp.	I
Orthoprosopa nigra Macq.	I
Eristalis pulchellus Macq.	I
Microdon modestus Ferg.	—
Anthomyiidae	
Lispa cana Walk.	I
Pygophora apicalis Schin.	I
Tachinidae	
Dexia sp.	I
Muscidae	
Musca domestica L.	I
Calliphoridae	
Lucilia sp.	I
Calliphora sp.	I
Sarcophagidae	
Sarcophaga sp.	I
Oestridae	
Oestrus ovis L.	—
Phycodromidae	
Ortalidae	I
Drospohilidae	I
Sapromyzidae	
Sapromyza sp.	I
Hippoboscidae	
Melophagus ovinus L.	—
Ortholfersia macleayi Leach	I
Ornithomyia sp.	I
Nycteribiidae	
Nycterebosca falcozi Jobl.	I

These are the anomalous absence of a peritrophic membrane in *Oestrus ovis* L. (which is perhaps not surprising since the adults do not have functional mouthparts and do not feed). A membrane is apparently also lacking in the adult sheep ked, *Melophagus ovinus* (L.), although it is clearly present in three other hippoboscid species examined and has been recorded in this family by Aschner

(1931). The third exception is the absence of a membrane in the three specimens examined of *Microdon modestus* Ferg., all other genera of Syrphidae so far examined possessing a well-defined type I membrane. Aubertot (1934) has described a type I peritrophic membrane in larvae of *Microdon.*

Although a type I membrane has not yet been recorded in adult nematocerous or orthorrhaphous flies, sheaths enclosing the food occur in many species, in spite of a mass of contradictory reports in the literature. Table 4 lists relevant records which have seldom been taken into consideration. In the blood-sucking species a sheath is recorded as being present only after a blood meal, and in *Simulium, Phlebotomus,* and *Anopheles* this sheath was shown to contain chitin. In these records (with the exception of the adult tipulid, in which the membrane is long and tubular) the sheaths appear to differ from the well-formed tubes so characteristic of other adult Diptera and to be similar to the type II membranes of other groups.

TABLE 4

PRESENCE OF MEMBRANES IN THE MIDGUT OF ADULT NEMATOCERA AND BRACHYCERA

Family	Genus and Species	Author
NEMATOCERA		
Tipulidae	*Tipula* sp.	Aubertot 1934
Culicidae	*Culex pipiens*	Schaudinn 1904
	C. fatigans	Pal 1943
	Ecculex vexans	Aubertot 1934
	Anopheles culicifacies	Pal 1943
	A. stephensi	Pal 1943
	A. subpictus	Pal 1943
	A. maculipennis	Yaguzhinskaya 1940
Psychodidae	*Phlebotomus papatasii*	Dolmatova 1942
	P. chinensis	Feng 1951
	P. congolensis	Feng 1951
Simuliidae	*Simulium damnosum*	Lewis 1950
	S. griseicolle	Lewis 1950
BRACHYCERA		
Tabanidae	Female sp.?	Olsufev (from Yaguzhinskaya 1940)
	Tabanus montanus	Engel 1924
	T. bovinus	Engel 1924
	T. bovinus	Aubertot 1934

Adult female *Aedes aegypti* (L.) and *Culex fatigans* were dissected at varying intervals after a blood meal. Shortly after feeding, the blood, which is passed into the enlarged posterior midgut (Fig. 2), was found to be surrounded by a soft 'gelatinous' zone (which stained blue with Mallory), but no discrete membrane could be detected. However, the day after feeding a thin, tough, transparent membrane could be separated from around the mass of partly digested blood. At its anterior end a short tubular extension of small diameter could sometimes be distinguished. The membrane appeared to be less well formed, or thinner, at the posterior end of the blood mass. This sac-like membrane gave a positive test for chitin. From its diameter it is clearly produced in the posterior midgut and not in the narrow tubular anterior midgut. Furthermore, when a second blood meal is taken before the first is digested the second meal partially or completely surrounds the first, and distinct membranes can be distinguished around both (Fig. 2). Some 20-24 hr after the second meal a thin chitin-containing membrane could be separated from around the entire food mass. These observations agree well with those of Yaguzhinskaya (1940) on *A. maculipennis.* No membrane was recovered from unfed mosquitoes or those fed on sugary solutions. Examination of sections of blood-fed adults demonstrated that the membrane could be detected in histological preparations (Plate 1, Fig. 8). It is tempting to postulate that the peritrophic membrane is produced only in response to a blood meal. Experience with adult tabanids, however, suggests that further observation is required to substantiate this conclusion.

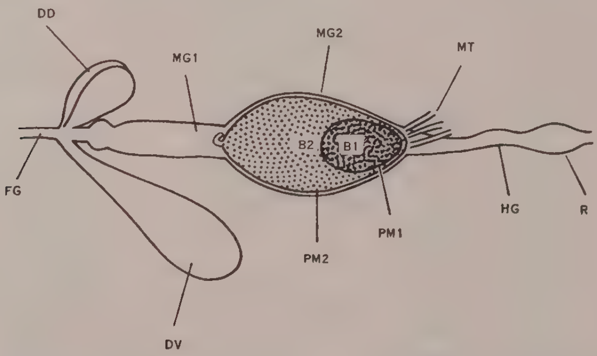


Fig. 2.—Diagram of digestive tract of adult female *Aedes aegypti* fed twice on blood. *B*1, first blood meal; *B*2, second blood meal; *DD*, dorsal diverticula; *DV*, ventral diverticulum; *FG*, foregut; *HG*, hindgut; *MG*1, anterior midgut; *MG*2, posterior midgut; *MT*, malpighian tubules; *PM*1, peritrophic membrane around first, largely digested, blood meal; *PM*2, peritrophic membrane surrounding second blood meal and residue of first meal; *R*, rectum.

In three species of adult tabanid, which contained no blood in their digestive tract, one or more pieces of membrane could be detected in the midgut of most specimens examined (Table 5). When individuals had fed to repletion on nectar or sugar solutions one length of tubular membrane was generally seen (through the transparent gut wall) protruding from the middle zone of the midgut a short distance into the enlarged posterior midgut. Another separate length often lay in this latter region (Fig. 3A). When the midgut was cut longitudinally, the former length of membrane could be traced to about the anterior end of the mid midgut. The small diameter of both lengths of membrane indicated quite clearly that they could not have been produced in the enlarged posterior region. These membranes gave a positive test for chitin.

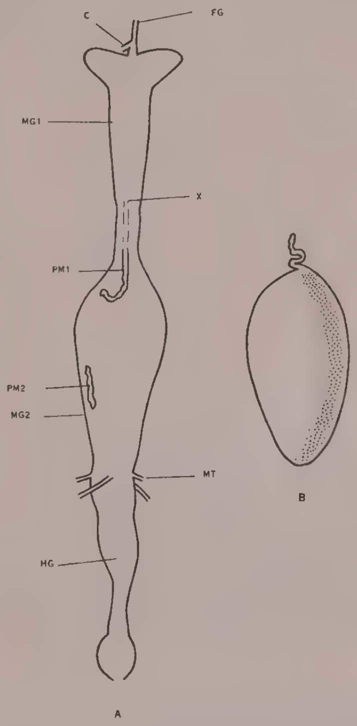


Fig. 3.—*A*, diagram of alimentary canal of nectar-fed *Dasybasis froggatti*.
B, blood meal with encircling membrane removed from posterior midgut of *Scaptia jacksoniensis*.
C, entrance of crop; *FG*, foregut; *MG*1, anterior midgut; *MG*2, posterior midgut; *MT*, malpighian tubules; *PM*1 and *PM*2, lengths of peritrophic membrane; *X*, most anterior level at which peritrophic membrane was detected.

One female *Scaptia jacksoniensis* was found to have in the enlarged posterior midgut a mass of partly digested blood enclosed in a membrane. A membrane of smaller diameter was attached to the anterior end of the membranous sac enclosing the blood (Fig. 3*B*). After washing the membrane clean in dilute alkali, it was subjected to the van Wisselingh test and gave a positive reaction for chitin. In the giant *S. guttata*, which measures 1 in. from the front of the head to the tip of the abdomen, the peritrophic membrane was very clearly seen. In this species it could be traced forwards to the level of the midgut caeca. Anteriorly it was thin and easily broken, but it became a far thicker and tougher structure in the posterior midgut, indicating that further material had been added to the sheath during passage down the midgut. Electron micrographs of the sheath enveloping the food in the posterior midgut reveal that it is without doubt a peritrophic membrane (Plate 2, Figs. 1 and 2). The photographs indicate that the membrane has a poorly organized structure compared with that of most of the other insects examined (Mercer and Day 1952), although all contain fibrils of a rather similar nature.

TABLE 5

OCCURRENCE OF A PERITROPHIC MEMBRANE (P.M.) IN TABANIDAE

Species	With P.M.		No P.M. Seen	
Dasybasis froggatti (Ric.)	6♂	1♀	2♂	1♀
Scaptia jacksoniensis (Guér.)	1♂	4♀		
S. guttata (Don.)		2♀		

All evidence so far available (Tables 3, 4, and 5) indicates that a chitin-containing type II peritrophic membrane occurs in representatives (not necessarily blood-sucking) of a number of nematocerous and orthorrhaphous Diptera. This membrane has often not been recognized in the past because it differs from the easily recognized type I membrane of higher Diptera and because it is absent or difficult to detect except when solid or semi-solid food is present in the midgut. Available evidence is inadequate to decide whether adults of some families of lower Diptera completely lack the capacity to produce a type II membrane.

(*d*) *Other Insects and Arthropods*

A number of insects and other arthropods were examined for the presence of a peritrophic membrane where additional information was desirable to substantiate or contradict earlier claims (Table 6).

In Thysanura the report of a peritrophic membrane in a silverfish (Lindsay 1940) is confirmed and the occurrence of a lamellar membrane arising from the general midgut epithelium is recorded in *Heterojapyx*.

In *Gryllotalpa* (Orthoptera) the presence of the four long plate-like extensions of the oesophageal invagination extending through the short midgut into the hindgut is confirmed. However, although the contents of the midgut are fluid in nature, fragments of membrane occur near the surface of the cells and these give a positive test for chitin. There is no doubt therefore that the midgut cells have not entirely lost their capacity to secrete a peritrophic membrane, although this membrane is not as well organized as in many other Orthoptera. Aubertot (1934) also observed membranous fragments which had originated from the midgut epithelium, but in the absence of a test for chitin failed to recognize their significance.

In *Nezara viridula* (Hemiptera : Pentatomidae) a sheath enclosing the food was not infrequently found in the enlarged second region of the midgut. Sheaths of smaller diameter are sometimes present within the contents of this region and in the third and fourth regions of the midgut. Although these sheaths may withstand KOH treatment for 3 hr at 160°C, a brown or blue (but not a purple) coloration was given on subsequent iodine treatment. Further work is required to determine whether chitin is present.

TABLE 6

OCCURRENCE OF A PERITROPHIC MEMBRANE IN VARIOUS ARTHROPODS

Where the presence of a membrane is indicated a positive test for chitin was obtained

Class	Order	Species	Membrane Type
Insecta	Thysanura	*Ctenolepisma longicaudata* Esch.	II
		Heterojapyx evansi Wom.	II
	Orthoptera	*Gryllotalpa coarctata* Walk.	II
	Embioptera	Unidentified	II
	Mallophaga	*Eomenacanthus stramineus* Nitz.	II
	Hemiptera	*Nezara viridula* (L.)	?
	Coleoptera	*Anthrenus vorax* Waterh.	II
		Calosoma schayeri Erichs.	II
	Hymenoptera	*Myrmecia nigriceps* Mayr.	II
		Promyrmecia pilosula Sm.	II
		Iridomyrmex detectus Sm.	—
		Camponotus consubrinus (Erich.)	—
	Mecoptera	*Harpobittacus australis* Klug	II
Onycophora		*Ooperipatus paradoxus* Bouv.	II
Myriapoda	(Chilopoda)	*Cormocephalus aurantipes* (Newp.)	II
		Allothereua maculata Newp.	II
Crustacea	Cladocera	*Simona* sp.	II

Contrary to the early and often-quoted report of Mobusz (1897), a chitin-containing peritrophic membrane occurs in the posterior half of the midgut in larvae of *Anthrenus* and other dermestids (illustrated and described by Waterhouse 1952). Aubertot's (1934) report of the presence of a peritrophic membrane in Carabidae is confirmed by the observation of a well-formed chitin-containing membrane in the posterior half of the midgut of *Calosoma* (Plate 1, Fig. 9).

Loele (1914) and von Dehn (1933) have reported the absence of a peritrophic membrane in adult ants belonging to the highly specialized genera *Formica, Myrmica,* and *Camponotus.* In the present investigations a well-formed type II peritrophic membrane has been observed in the posterior two-thirds of the midgut of two species of adult ants belonging to the primitive subfamily Ponerinae. However, no membrane could be detected in the more specialized adults of *Iridomyrmex* (Dolichoderinae) or *Camponotus* (Formicidae).

In Mecoptera a peritrophic membrane was observed in adult *Harpobittacus,* although Grell (1938) reported its absence in both larval and adult *Panorpa.*

In arthropods other than insects, the report of a chitinous peritrophic membrane in Onycophora (*Peripatus*, Manton and Heatley 1937) is confirmed for *Ooperipatus*. Further, a chitinous membrane was detected in a cladoceran (Crustacea) and in the posterior midgut of two chilopods (Myriapoda). The former record substantiates the work of Chatton (1920), Farkas (1922), and Aubertot (1934) and the latter record is in agreement with the early reports of Plateau (1878), Balbiani (1890), and others of the presence of a peritrophic membrane in some myriapods.

It is evident from these and other records in this paper that a chitin-containing membrane is present in the midgut of many insects commonly believed to lack a peritrophic membrane. Careful examination of additional species may be expected to reduce the number of groups at present regarded as forming no peritrophic membrane.

IV. Discussion

Much of the confusion and discussion about the merits and occurrence of the two alternative methods of peritrophic membrane formation appears to stem from a rather widely held belief that the midgut epithelium, unlike that of the fore- and hindgut, is basically unable to secrete chitin. Indeed the cells at the anterior end of the midgut which secrete the type I membrane have been stated to arise from the stomodaeum (Gambrell 1933; Butt 1934), this 'explaining' their ability to produce chitin. However, the principal evidence that the endodermal midgut epithelium is unable to secrete chitin appears to be by inference from the absence of a cuticular inner lining to this epithelium. I am indebted to Professor O. W. Tiegs for drawing attention to the evidence that, at least in some insects, the midgut is actually ectodermal in origin, since it comes from the stomodaeum and proctodaeum. If this evidence is accepted the position becomes further simplified. Be this as it may, from the facts now available it is impossible to disregard the overwhelming weight of evidence that in many insects a chitin-containing membrane enveloping the food is produced by delamination or secretion from all, or only a restricted portion, of the midgut epithelium.

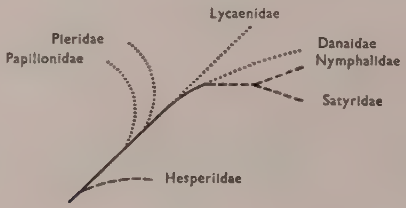
One of the principal difficulties encountered in any survey of the occurrence of a peritrophic membrane in insects is the nature of the criteria on which records of its presence have been based. In insects in which the peritrophic membrane is produced solely or mainly at the anterior end of the midgut this membrane does not vary greatly in appearance from species to species and its presence can be distinguished without difficulty. However, when the membrane is formed by delamination from the midgut epithelium (and then sometimes only in the middle or in the posterior half of the midgut and perhaps only after ingestion of food), it becomes progressively more difficult to be sure from its gross morphology that a true structural membrane is present. Since there is little doubt that the capacity to form a well-defined peritrophic membrane has been lost on a number of occasions during evolution, it is not improbable that there are many intermediate stages in this process.

Structurally imperfect membranes formed of the same materials as highly organized membranes are difficult to place in any scheme based on gross morphology alone. In the absence of information on their fine structure the most important criterion for the occurrence of a peritrophic membrane would appear to be the presence of chitin in the membrane. Unfortunately this information is not available for many of the species reported in the literature, and indeed it is often no easy matter to locate a membrane for test (particularly some of the thin delaminated membranes) following the KOH treatment required for the van Wisselingh test. Furthermore even the demonstration of chitin does not resolve the question of whether the membranes formed by the two methods are truly homologous. When information becomes available on the fine structure of the membranes arising at the anterior end of the midgut, for comparison with that already available on the delaminated type, the situation may be clarified. However, an oriented fibrillar network can scarcely be expected if, as appears both from living and from fixed material, the precursor of the type I membrane streams continuously off the bottom of the mass of cells producing it and particularly if, as suggested by Wigglesworth (1930), this secretion is moulded by passage through an annular cleft between the oesophageal invagination and the midgut.

If the two types of membrane prove to be homologous, one may perhaps picture all cells of the ancestral insect midgut epithelium as being capable of secreting chitin and protein either continuously or periodically, and perhaps only in response to the presence of food. The capacity to secrete chitin may have become progressively restricted in some species or groups either to the anterior, middle, or posterior zones of the midgut or lost completely. On this scheme the type I membrane might be pictured as being produced by restriction of the secreting cells to the extreme anterior portion of the midgut, unless these cells are in fact of ectodermal origin, a view that now requires careful re-examination. The type II membranes are divisible into several subtypes. These range from the multilayered membranes produced from the general midgut epithelium to those which appear to be single-layered and produced by a restricted zone, generally the posterior zone, of the midgut.

Since the delaminated type II membranes are produced from the surface of cells carrying a striated border, it seems highly probable, as suggested by Mercer and Day (1952), that the 'holes' in the network correspond with the spaces occupied by the individual rodlets of the striated border. Fibril formation and orientation are then pictured as occurring within the striated border and near the cell surface. During the detachment of the sheets of peritrophic membrane from the striated border additional material may be added, to produce membranes with amorphous material overlying the network and filling the interstices. One difficulty in this interpretation is that the mesh size may apparently vary in adjoining areas of membrane (Mercer and Day 1952, Fig. 7). Perhaps this results from the rodlets of the border varying in diameter as a result of fluctuations in length. Wigglesworth (1931), for example, has recorded marked changes in the length of the striated border of the malpighian tubules of *Rhodnius* during different phases of activity.

It is difficult to suggest any function for the peritrophic membrane in the adult Lepidoptera and Diptera in which it occurs and particularly where it is present only in the posterior portion of the midgut. Adult Lepidoptera, whether they possess a membrane or not, normally ingest only fluids (nectar, fermenting plant juices, water, etc.). Although adult Diptera have a more varied diet and small particulate material is frequently ingested, there is little reason to believe that the unprotected midgut epithelium would be subjected to damage. Furthermore, no advantage appears to be conferred upon species which possess a well-developed type I peritrophic membrane.



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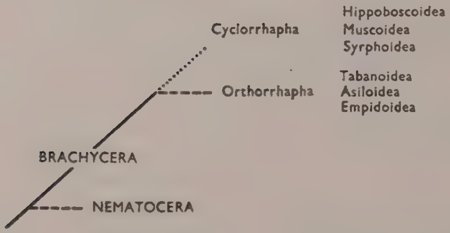

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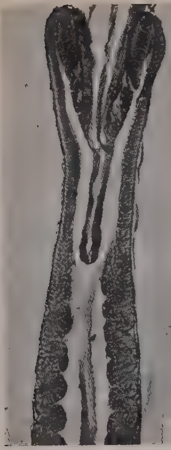
Fig. 4.—Relationships of families of butterflies examined.
Fig. 5.—Relationships of families of Diptera examined.
Dotted lines indicate presence of a type I peritrophic membrane. Dashes indicate the absence of a membrane or the occasional presence of a type II membrane.

A peritrophic membrane of the delaminated type appears to be present in most primitive or unspecialized insects (e.g. Collembola (Folsom and Welles 1906), Thysanura, and Mecoptera). A peritrophic membrane is possessed also by related groups, such as the Onycophora, Myriapoda, and some Crustacea. Where it does not occur in insects there appears to be good reason to believe that it has been lost, rather than that it has evolved independently on a very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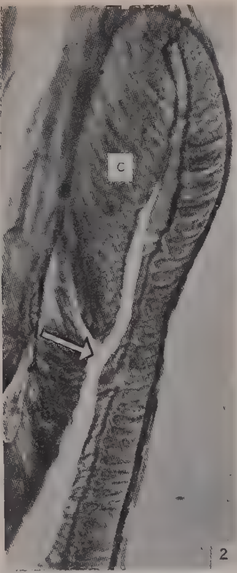

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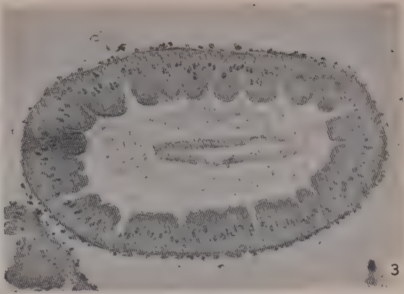
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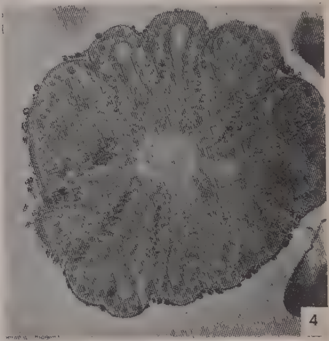
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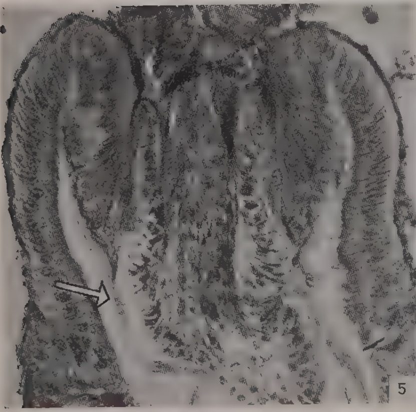
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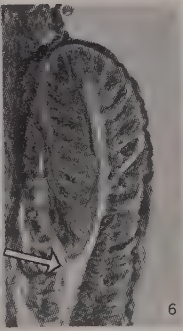
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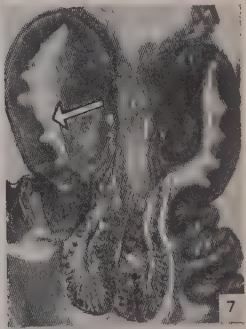
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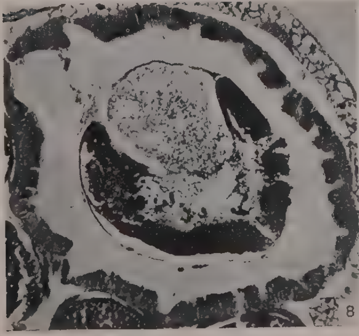
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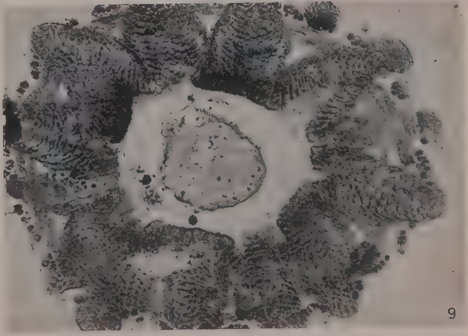
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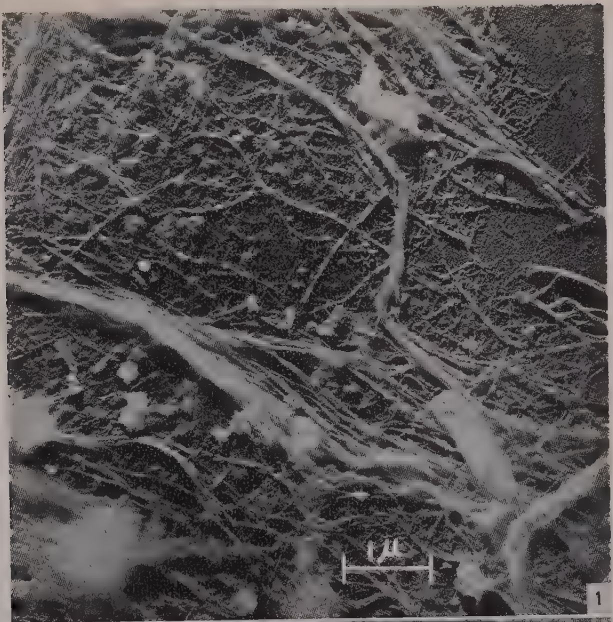

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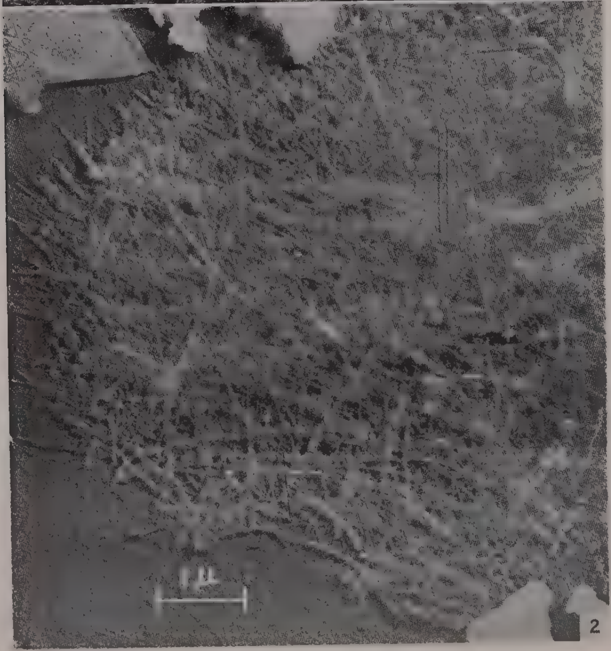

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large number of occasions in the various orders. The mutations causing modification of type or loss of the peritrophic membrane are probably only exceeded in frequency of detection throughout the various orders of insects by the changes resulting in loss of wings. It would be interesting to determine whether or not a peritrophic membrane is present in all the many *Drosophila* mutants, particularly those in which cuticular structure (e.g. bristle formation) is affected.

Where a peritrophic membrane is still present in fluid-feeding species, it appears that there has simply been no selection pressure for its removal and furthermore no chance selection as ancestral stock of individuals which have lost it. This may, however, be an over-simplification, since a peritrophic membrane (of type I at least) appears to be absent fairly generally in the more primitive adult Lepidoptera and Diptera and present in many of the more specialized families. The parallel in these two orders extends further to the presence of a peritrophic membrane in all larvae so far examined, with the possible exception of one or two Diptera (Nematocera) (Aubertot 1934; Barendrecht 1941).

In some instances the presence or absence of a peritrophic membrane might appear to be a character of assistance to the taxonomist.

Figure 4 is an attempt to indicate both the relationships of the families of butterflies examined and the presence of a type I peritrophic membrane (dotted lines). The dashes indicate the absence of a membrane or the occasional presence of a type II membrane. A similar scheme can be constructed also for adult Diptera (Fig. 5).

In butterflies, the presence of a type I peritrophic membrane in Danaidae and its absence in Nymphalidae and Satyridae lend support to the view (Ford 1946) that the Danaidae should be regarded as a separate family rather than as a subfamily of a single enormous family, the Nymphalidae. From the numerous exceptions already noted to any generalization about the occurrence of a peritrophic membrane it is clear, however, that it can provide only confirmatory evidence to the taxonomist. It would be interesting to know whether the many other groups at present considered as subfamilies of the Nymphalidae possess a type I peritrophic membrane and also whether it occurs in the Riodinidae, a family generally placed between the Nymphalidae and the Lycaenidae.

V. Acknowledgments

Grateful acknowledgment is due to Mr. I. F. B. Common for identifying the moths, to Dr. S. J. Paramonov for identifying the flies, and to these and many other colleagues in the Division of Entomology, C.S.I.R.O., both for supplying living insects and for stimulating discussions. The electron micrographs were supplied by Mr. J. L. Farrant, Division of Industrial Chemistry, C.S.I.R.O. The photograph of the peritrophic membrane in *A. aegypti* was from a section prepared by Dr. M. F. Day.

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EXPLANATION OF PLATES 1 AND 2

PLATE 1

Fig. 1.—L.S. anterior midgut of adult *Pieris rapae* (Pieridae) showing the tubular type I peritrophic membrane arising at level of oesophageal invagination.

Fig. 2.—Portion of Figure 1 at higher magnification. Note that the cells (*C*) secreting the membrane line the inner wall of the invagination. The membrane may be seen leaving the posterior end of this group of cells (arrow) and also more posteriorly near the surface of the striated border.

Fig. 3.—T.S. midgut of adult *Neolucia agricola* (Lycaenidae).

Fig. 4.—T.S. posterior midgut of adult *Heteronympha merope* (Nymphalidae).

Figs. 5 and 6.—L.S. oesophageal invagination of adult *Cydia pomonella* (Eucosmidae), showing origin of the type I peritrophic membrane (arrow).

Fig. 7.—L.S. oesophageal invagination of adult *Euphyia severata* (Larentiidae), showing anterior origin of peritrophic membrane (arrow).

Fig. 8.—T.S. posterior midgut of adult female *A. aegypti*, 45 hr after a blood meal. The partly detached peritrophic membrane surrounds the incompletely digested blood.

Fig. 9.—T.S. midgut of *Calosoma schayeri* (Carabidae).

PLATE 2

Figs. 1 and 2.—Electron micrographs of peritrophic membrane from posterior midgut of blood-fed *Scaptia guttata* (Tabanidae), showing its fibrillar nature.

THE AUSTRALIAN SPECIES OF HELIOTHIS (LEPIDOPTERA: NOCTUIDAE) AND THEIR PEST STATUS

By I. F. B. Common[*]

[*Manuscript received July* 6, 1953]

Summary

The taxonomic and pest status of the species of *Heliothis* occurring in Australia have been examined and it is shown that two pest species have previously been confused under the name of *H. armigera* (Hübner).

H. armigera has a limited distribution, mainly in coastal and subcoastal eastern Australia and in the Northern Territory. It also occurs widely in Europe, Africa, India, New Zealand, and the islands of the south-west Pacific. In North America another closely related species, probably *H. umbrosus* Grote, has previously been synonymized with *H. armigera*. Widely distributed in Australia, *H. punctigera* Wallengren has hitherto been referred to in the Australian economic and taxonomic literature as *H. armigera*. In addition, two other species, *H. assulta* Guenée and *H. rubrescens* (Walker), occur in Australia but have not so far been recognized as pests.

Descriptions and illustrations of the four species, including the male and female genitalia, and keys to the males and females, are provided. The genitalia of both sexes of the North American species are also figured.

INTRODUCTION

In recent years an enormous volume of literature has appeared on the ecology and control of *Heliothis armigera* (Hübner) which, according to the latest summary by the Commonwealth Institute of Entomology (1952), has a world-wide distribution. However, there is much conflicting ecological information not readily explained by the climatic and host differences pertaining in the various parts of its reputed range. In Australia it has been reported as a pest in every State, although its importance appears to have varied widely. In order to determine if the ecological differences could be correlated with specific differences in morphology a critical examination of specimens from each State of the Commonwealth and from abroad has been undertaken.

Two widely distributed species of *Heliothis, H. armigera* (Hübn.) and *H. assulta* Guenée, have been recorded from Australia by Hampson (1903) and, in addition, four other names have been proposed by various authors for Australian species. In 1858 Walker described *Thalpophila rubrescens* from Moreton Bay; Wallengren described *Heliothis punctigera* in 1860 from Sydney; in 1911 Turner described *Chloridea aresca* from Toowoomba and in 1920 described *Heliothis hyperchroa* based on specimens from Stanthorpe, Queensland, from Lawson, N.S.W., and from Tasmania. Hampson (1903) included *T. rubrescens*

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Walker and *H. punctigera* Wallengren in the synonymy of *H. armigera* and, in addition, *H. pulverosa* Walker and *H. uniformis* Wallengren from South Africa, *H. conferta* Walker from New Zealand, and *H. umbrosus* Grote from North America. As synonyms of *H. assulta* he listed *H. temperata* Walker and *H. succinea* Moore from India and *H. separata* Walker from Samoa.

Swinhoe (1900) considered *H. rubrescens* (Walk.) to be a good species and stated that previous records of this species from India were based on misidentified specimens of *H. armigera.* Hampson (1903), however, regarded *H. rubrescens* as only a variety of *H. armigera* and in this he was followed by Turner (1920).

The male and female genitalia of *H. armigera* have been figured by Pierce (1909, 1942), but with insufficient detail for critical determination. Siverly (1947) described and figured the genitalia of both sexes of North American specimens referred to this species.

In this study, the types or topotypical specimens of most of these species have been examined, with special reference to the genitalia of both sexes. In addition, series of specimens from North America, India, New Zealand, and Fiji have been compared.

The material upon which this revision is based came from the collections of the Queensland Museum and the Department of Agriculture and Stock, Brisbane; the Australian Museum and the Department of Agriculture, Sydney; the National Museum of Victoria, Melbourne; the South Australian Museum and the Waite Agricultural Research Institute, Adelaide; the Tasmanian Department of Agriculture, Hobart; the Western Australian Department of Agriculture, Perth; the Division of Entomology Museum, C.S.I.R.O., Canberra, which includes the collection of the late A. J. Turner; the Department of Agriculture, Fiji; the D.S.I.R., Auckland, N.Z.; the Indian Agricultural Research Institute, New Delhi, India; the Canadian Department of Agriculture, Ottawa, Canada; the British Museum (Natural History), and the Naturhistoriska Riksmuseum, Stockholm, Sweden.

Genus HELIOTHIS Ochsenheimer

Heliothis Ochsenheimer, 1816, Die Schmetterlinge von Europa **4: 91.**

Type species *Noctua dipsacea* Linnaeus.

Proboscis fully developed; labial palpi oblique, apical segment porrect; frons smooth, rounded, with scales forming a smooth prominence above clypeus; eyes smooth; antennae in male shortly ciliated, in female sometimes minutely ciliated. Thorax with scales smooth, forming a median ridge. Anterior tibiae with a pair of apical spines and several lateral spines; mid and hind tibiae with lateral spines only. Abdomen not tufted.

The name *Heliothis* was first used by Hübner in his Tentamen Lepidopterorum (1806) and again in his Erste Zutrage zur Sammlung exotischer Schmetterlinge (1808), but it appears to have been first used validly in 1816 by Ochsenheimer for a group of moths including *Noctua dipsacea* Linn. It is open to doubt whether Hübner's *nomen nudum, Heliothis jucunda* 1808, should be regarded as subsequently validated by an illustration published in his Zutrage zur Sammlung exotischer Schmetterlinge, which bore only a number and to which he applied the name *Melipotis jucunda* in the text of the Zutrage in 1818 (see Hemming 1937). However, Hampson (1903) did not regard Ochsenheimer's genus as validly described and attributed the genus *Heliothis*, with type species *Noctua cardui* Esp., to Treitschke (Die Schmetterlinge von Europa 5 (3): 215, 1826). Accordingly, he placed several species, including *Noctua armigera* Hübn., in the genus *Chloridea* Westwood, 1941 (Jardine's Nat. Libr. 32: 198) with type species *Noctua virescens* Fabr. Tams (1935), however, pointed out that when Ochsenheimer used the name *Heliothis* he indicated quite definitely the group of species which he included under this name, and on the grounds of this indication the genus should be ascribed to him and not to Treitschke. In 1829 Thon (In Ersch and Gruber, Allgemeine Encyclopädie der Wissenschaften, Sect. II (5): 131) had given the first type citation for the genus *Heliothis* Ochsenheimer as *N. dipsacea* Linn. from Europe, which antedates Hampson's selection of *N. cardui* Esp.

The genus *Heliothis* in this sense contains several species, including *H. armigera* (Hübn.). Tams (1935) stated that Hampson (1903, p. 657) should not have replaced the trivial name *armigera* by *obsoleta* Fabricius, because Fabricius' name *Bombyx obsoleta* (1793, Ent. Syst. 3 (1): 465) is a primary homonym of *Bombyx obsoleta* Fabr., 1775 (Systema Entomologiae, p. 579, No. 77) now placed in the family Lymantriidae (see also Heinrich 1939).

The genitalia of the female type of *Thalpophila rubrescens* Walk. in the British Museum show that this species is quite distinct from European specimens of *H. armigera* and is in fact identical with *Chloridea aresca* Turn. which must now be regarded as a synonym of *H. rubrescens*. The writer has been unable to locate the type of *H. hyperchroa* Turner, but specimens included under this name in the National Museum of Victoria, presumably by Turner, who named most of the Lyell collection in that Museum, are conspecific with *H. rubrescens*. Turner himself, in his unpublished card catalogue, added *H. hyperchroa* to the synonymy of *H. armigera*. He described the forewings of his type as crimson, but all the specimens with pink to red forewings so far examined have proved to be only a form of *H. rubrescens*. It is therefore highly probable that *H. hyperchroa* should be added to the synonymy of *H. rubrescens*.

The genitalia of the British Museum types of *H. separata* Walk. and *H. succinea* Moore, and the Oxford University Museum type of *H. temperata* Walk. have been compared with the lectotype of *H. assulta* Guen. in the Paris Museum and with specimens from Queensland. All these specimens are conspecific.

The British Museum types of *H. pulverosa* Walk. from the Cape of Good Hope and of *H. conferta* Walk. from Auckland, N.Z., have also been dissected and compared with specimens of *H. armigera* from Europe and a series of specimens from Queensland, New South Wales, New Zealand, Fiji, and India. They are all conspecific but differ from specimens referred to *H. armigera* from Canada and the United States. It is concluded therefore that *H. armigera* does not occur in North America. For the American species the name *umbrosus* Grote 1863 (Proc. Ent. Soc. Philad. 1: 219), based on a specimen from New York, should probably be used.

A long series of Australian specimens previously referred to *H. armigera* has now been examined and it is clear that two distinct species have been confused under this name. In Australia, *H. armigera* appears to be largely confined to coastal and subcoastal Queensland and New South Wales, and a specimen in the British Museum came from Darwin. Two specimens from near Adelaide and another labelled "South Australia," probably collected more than 50 years ago, are in the South Australian Museum. Widely distributed throughout most of Australia, with the possible exception of coastal Queensland north of Brisbane, is a second species, the genitalia of which are identical with those of the male type of *H. punctigera* Wallengr. (Fig. 1). Wallengren's Latin description of 1861 is remarkably detailed and could refer to no other Australian species.

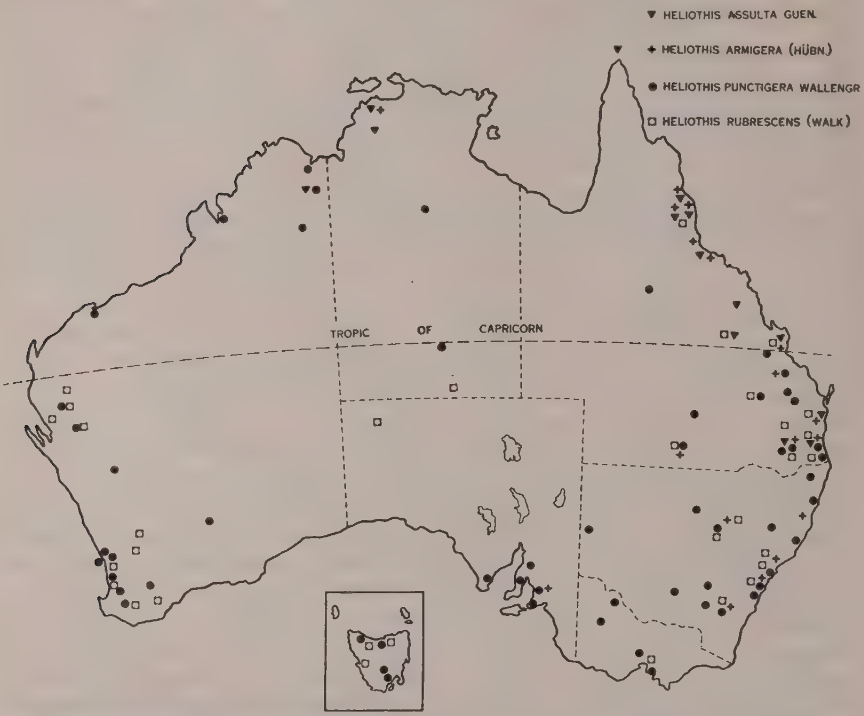

▼ HELIOTHIS ASSULTA GUEN.
✦ HELIOTHIS ARMIGERA (HÜBN.)
● HELIOTHIS PUNCTIGERA WALLENGR
☐ HELIOTHIS RUBRESCENS (WALK.)
TROPIC OF CAPRICORN

Fig. 1.—Distribution of *Heliothis assulta* Guen., *H. armigera* (Hübn.), *H. punctigera* Wallengr., and *H. rubrescens* (Walk.), based on adult records.

Two other monotypic Australian genera are closely related to *Heliothis*. *Neocleptria* Hampson (1903), with type species *Heliothis punctifera* Walker, may be separated by the absence of lateral spines on the anterior tibiae, by the projecting transverse ridge of the frons, and by the female genitalia in which the bursa copulatrix lacks signa. *Astonycha* Turner (1920) was based on *A. litarga* Turner, described from a unique male specimen now in the Division of Entomology Museum, C.S.I.R.O., Canberra. No further specimens are known and the abdomen of the type is damaged. The type species differs from *Heliothis* and *Neocleptria* by the spining of the legs and the male aedeagus. The anterior tibiae lack the distal claws present in both *Heliothis and Neocleptria* and the lateral spines present in *Heliothis,* and the aedeagus has 2 long, curved, and flattened cornuti, lying side by side and directed posteriorly.

KEY TO AUSTRALIAN SPECIES OF THE GENUS HELIOTHIS

Males

1. Ground colour of both wings ochreous yellow, subterminal line forming 3 well-defined dentations on M_3, Cu_1, and Cu_2, subterminal fascia on under side of forewing continued to costa; aedeagus without sclerotized process within distal orifice . . . . *H. assulta* Guen.

Ground colour of both wings not ochreous yellow, subterminal line not forming well-defined dentations, subterminal fascia on under side of forewings not continued to costa; aedeagus with sclerotized process within distal orifice 2

2 (1). Forewing ochreous grey or pink, postmedial line very acutely dentate; aedeagus with spiny process within distal orifice. . . . . *H. rubrescens* (Walk.)

Forewing not ochreous grey or pink, postmedial line not acutely dentate; aedeagus with single thorn or spine within distal orifice. 3

3 (2). Forewings with indistinct transverse lines, sub-basal, antemedial, and medial lines absent; aedeagus with long, backwardly directed spine within distal orifice. . . .
H. punctigera Wallengr.

Forewings with transverse lines distinct; aedeagus with short, backwardly curved thorn within distal orifice. . . . . *H. armigera* (Hübn.)

Females

1. Basal area of hindwing ochreous, ochreous yellow or ochreous orange, without grey suffusion; inner surface of bursa seminalis without minute spines. 2

Basal area of hindwing whitish, suffused with grey, especially towards base; inner surface of bursa seminalis densely clothed with minute spines. 3

2 (1). Ground colour of forewing ochreous yellow, subterminal line distinct, forming 3 well-defined dentations on M_3, Cu_1, and Cu_2, subterminal fascia on under side of forewings continued to costa; bursa seminalis spirally coiled. . . . .
H. assulta Guen.

Ground colour of forewing dark reddish brown or pink, subterminal line when present not dentate, subterminal fascia on under side of forewings not continued to costa; bursa seminalis not spirally coiled. . . . . *H. rubrescens* (Walk.)

3 (1). Transverse lines on forewing distinct; pale marginal patch present between veins M_3 and Cu_2 in black terminal fascia of hindwing; bursa copulatrix nearly symmetrical, ovoid; genital plate deeply cup-shaped. . . . . . *H. armigera* (Hübn.)

Transverse lines on forewing indistinct; black terminal fascia of hindwing not interrupted by pale marginal patch; bursa copulatrix asymmetrical; genital plate parallel-sided . . . . *H. punctigera* Wallengr.

Description of species

HELIOTHIS ASSULTA Guenée

Figs. 2*A*, 3*A*; Plate 1, Figs. 4-6

Heliothis assulta Guenée, 1852, Hist. Nat. Ins., Spec. Gen. Lepid., vi, Noctuelites **2**: 178-9.
Heliothis temperata Walker, 1857, List. Lep. Ins. Coll. Brit. Mus. **11**: 689 (type locality: India).

Heliothis separata Walker, 1857, List Lep. Ins. Coll. Brit. Mus. **11**: 691 (type locality: Samoa).

Heliothis succinea Moore, 1881, Proc. Zool. Soc. Lond. **1881**: 362 (type locality: Bombay, India).

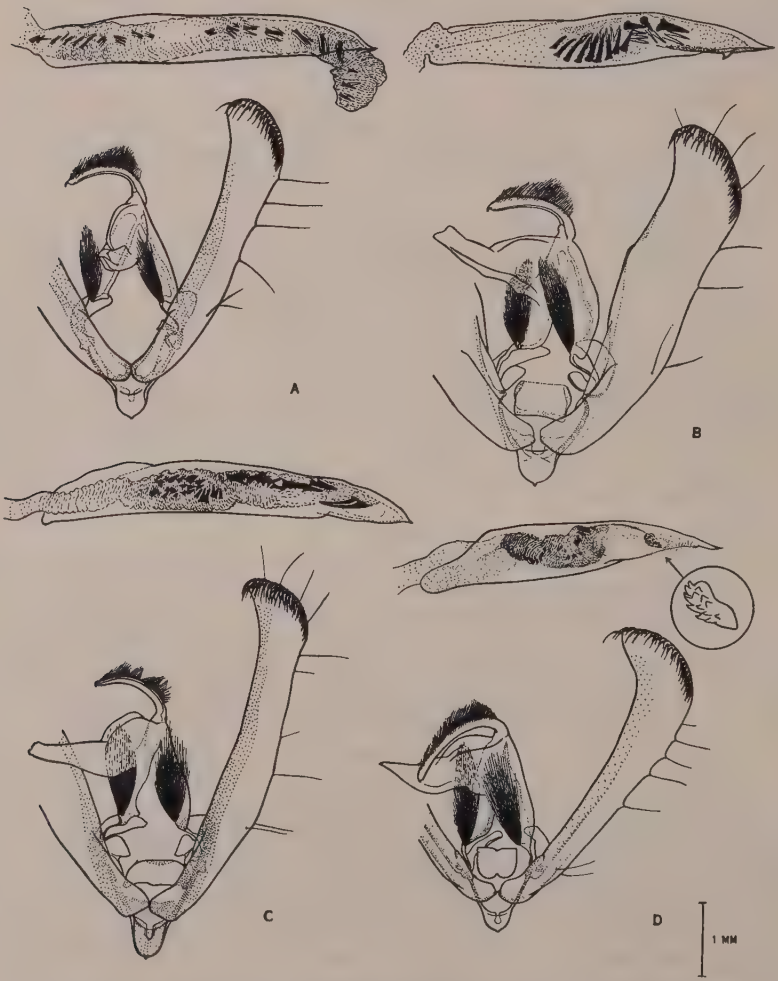


Fig. 2.—Male genitalia of *A*, *Heliothis assulta* Guen.; *B*, *H. armigera* (Hübn.); *C*, *H. punctigera* Wallengr. (*type*); and *D*, *H. rubrescens* (Walk.) (type of *H. aresca* Turn.) (camera lucida).

Male

Head and thorax greyish ochreous; antennae ochreous; legs ochreous, tibiae and tarsi suffused with brown; abdomen ochreous yellow. Forewing ochreous

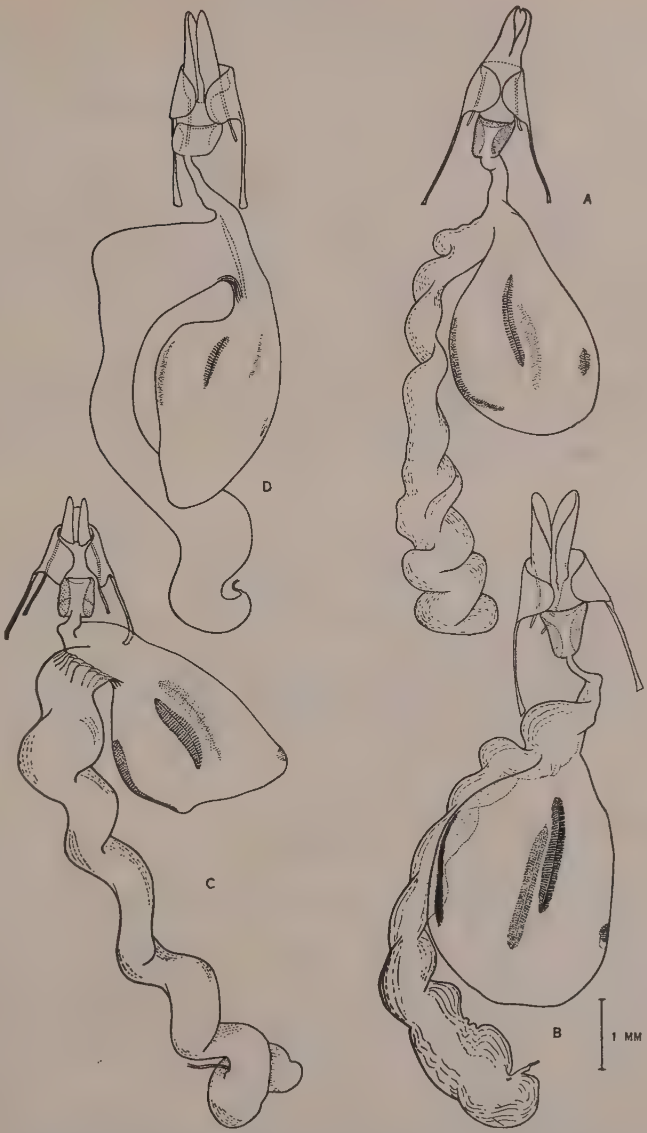


Fig. 3.—Female genitalia of *A, Heliothis assulta* Guen.; *B, H. armigera* (Hübn.); *C, H. punctigera* Wallengr.; and *D, H. rubrescens* (Walk.) (camera lucida).

yellow with distinct, brownish orange transverse lines; sub-basal line oblique, extending from costa to centre of wing; antemedial line double, strongly waved; medial line strongly angled outwards on *Cu*; postmedial line double, the inner one dentate, the outer gently waved; subterminal line angled outwards at R_5 and again to form 3 well-defined dentations on M_3, Cu_1, and Cu_2; the area between the postmedial and subterminal lines brownish orange, paler towards termen; orbicular and reniform distinct with brownish orange centre and ring. Hindwing ochreous yellow with broad, more or less distinct, dark fuscous, terminal fascia, interrupted by an indistinct orange patch on margin between veins M_3 and Cu_2. Under side of both wings ochreous yellow, with fairly distinct subterminal transverse fascia fuscous, suffused with reddish, extending from costa of forewing to near dorsum, and from costa of hindwing to near tornus, having a narrower line of the same colour parallel and close to the inner edge of fascia; forewing with dark fuscous orbicular and reniform.

Female

Forewing similar to male but ground colour and transverse lines darker and more distinct. Hindwings with terminal fascia on upper side broader and darker than in male. Under side of both wings with subterminal fascia darker than in male and with less reddish suffusion.

Genitalia

Male: Valve narrow, broader towards apex, costa gently curved; aedeagus cylindrical, without inner sclerotized process near distal orifice; vesica with apical and proximal bands of cornuti, with approx. 10 heavily sclerotized cornuti and numerous lightly sclerotized cornuti in each band, those near the centre of each being the largest.

Female: Genital plate deeply cup-shaped; bursa copulatrix ovoid, signa 1 short and 3 long, heavily sclerotized, roughened ridges; bursa seminalis spirally coiled. heavily sclerotized, without minute spines on inner surface.

Expanse

Male: Mean 34.1 mm (range 32.4-36.0).

Female: Mean 34.5 mm (range 32.0-37.2).

Type locality: Tahiti.

Type in the Muséum National d'Histoire Naturelle, Paris.

Specimens examined: 6 ♂, 23 ♀.

QUEENSLAND: Atherton, 20.i.1904, A.B.B., 1 ♀ (Nat. Mus.). Banks Is., Torres Strait, J. W. Schomberg, 1 ♂ (Aust. Mus.). Brisbane, Mar., 1 ♀ (C.S.I.R.O.); 22-29.iv.1914, 1 ♀ (Aust. Mus.); 27.x.1915, 1 ♀; 24.ix.1916, 1 ♀; 10.iv.1928, 1 ♀; 5.i.1933, 1 ♀; 14.v.1934, 1 ♀; Apr. 1942, 1 ♀ (all C.S.I.R.O.). Cairns, 20.i.1950, C. Oke, 2 ♀ (Nat. Mus.). Clermont, K. K. Spence, 1 ♀ (Aust. Mus.). Eungella, 9.x.1928, 1 ♂ (Fig. 2A) (C.S.I.R.O.). Kuranda, Apr. 1910, F. P. Dodd, 1 ♀ (C.S.I.R.O.). Meringa, Mar. 1923, E.J., 1 ♂, 1 ♀; 19.xi.1923, E.J., 1 ♀; 1.i.1925, C.B., 1 ♀; 7-9.iii.1929, E.J., 3 ♀; 2.v.1929, E.J., 1 ♀; 27.xii.1929, E.J., 1 ♂ (all Nat. Mus.). Milmerran, 1.i.1928, J. Macqueen, 1 ♀ (Nat. Mus.). Montville, 12.iii.1920, 1 ♀ (Fig. 3A) C.S.I.R.O.). Rockhampton, 12-15.viii.1952, I. F. B. Common, 2 ♀ (C.S.I.R.O.). Toowoomba, 13.ix.1921, W. B. Barnard, 1 ♂ (Qld. Mus.). Townsville, 7.vi.1927, 1 ♂ (C.S.I.R.O.).

WESTERN AUSTRALIA: Kimberley Research Station, 4.xii.1951, R. Lukins, 1 ♀ (W.A. Dept. Agric.).

NORTHERN TERRITORY: Brocks Creek, 12.v.1932, T. Campbell, 1 ♀ (C.S.I.R.O.).

The author has also examined specimens from Cocos I.

Comments

H. assulta also occurs in Samoa and the Oriental and Ethiopian Regions. It is readily distinguished from the other species of *Heliothis* in Australia by the ochreous yellow forewings, the subterminal line forming 3 well-defined dentations on veins M_3, Cu_1, and Cu_2, and by the subterminal fascia extending to the costa on the under side of the forewing. In the male genitalia, the valves are much narrower than in *H. armigera* and, unlike the other Australian species of *Heliothis,* the aedeagus lacks an inner thorn-like or spiny process near the distal orifice. The female genitalia are rather similar to those of *H. armigera* but are distinguished from this species and *H. punctigera* by the absence of minute spines on the inner surface of the bursa seminalis. The spirally coiled bursa seminalis distinguishes it from *H. rubrescens.*

HELIOTHIS ARMIGERA (Hübner)

Figs. 2*B*, 3*B*; Plate 1, Figs. 1-3

Noctua armigera Hübner, 1805, Sammlung europäischer Schmetterlinge Noctuae (Lepidoptera IV), pl. 79, fig. 370.

Heliothis armigera (Hübner) Ochsenheimer, 1826, Die Schmetterlinge von Europa **5** (3): 215. Butler, 1883, Proc. Zool. Soc. Lond. **1883**: 162. Hampson, 1894, Fauna Brit. India, Moths **2**: 174-5. Swinhoe, 1900, Cat. Eastern Australian Lep. Heterocera Oxford Univ. Mus., Pt. II: 591. Meyrick, 1912, Trans. N.Z. Inst. **44** (1911): 93. Meyrick, 1928, Revised Handb. Brit. Lepidoptera, p. 91. Hudson, 1928, Butterflies Moths N.Z. p. 46, pl. 6, fig. 26, and pl. 1, figs. 15, 16 (larvae). Tams, 1935, Insects of Samoa **2** (3) (Lepidoptera): 196.

Heliothis pulverosa Walker, 1857, List Lep. Ins. Coll. Brit. Mus. **11**: 688 (type locality: Cape of Good Hope, South Africa).

Heliothis conferta Walker, 1857, List Lep. Ins. Coll. Brit. Mus. **11**: 690 (type locality: Auckland, N.Z.).

Heliothis uniformis Wallengren, 1860, Wien. ent. Monatschr. **4**: 171 (type locality: Wahlberg, South Africa).

Chloridea armigera (Hübner) Hampson, 1903, Cat. Lep. Phalaenae Brit. Mus. **4**: 45.

Chloridea obsoleta (Fabricius) Hampson, 1903, Cat. Lep. Phalaenae Brit. Mus. **4**: 657.

Heliothis obsoleta (Fabricius) Turner, 1920, Trans. Roy. Soc. S. Aust. **44**: 131.

Male

Head and thorax olive-ochreous to greyish ochreous, sometimes with pinkish suffusion on labial palpi and antennae; legs greyish brown, sometimes suffused with pink; abdomen greyish ochreous. Forewing olive-ochreous to dull ochreous, transverse lines orange-brown to greyish brown; sub-basal line indistinguishable; antemedial line double, the inner one very indistinct, the outer angled outwards near costa, and again below cell and near dorsum; medial line indistinct, from ½ costa to reniform, then continued obliquely inwards to ½ dorsum; postmedial line double, the inner one very distinct except near costa, dentate, sharply angled outwards on M_3, the outer one diffused, usually containing minute white dots on veins R_5 to Cu_2; subterminal line indistinct, angled outwards on R_5 and slightly dentate on M_3, Cu_1, and Cu_2; area between postmedial and subterminal lines slightly darker in basal ½ and on costa; orbicular a brownish black dot with a ring of greyish brown or brown; reniform very distinct with brownish black centre surrounded by a greyish brown or brown quadrangle, with its outer side joined to costa by a short oblique bar; a series of minute, black, terminal dots between the veins; cilia reddish brown. Hindwing whitish ochreous to ochreous, suffused with grey towards base and with veins outlined with fuscous; broad black terminal fascia, narrowing towards costa and tornus, interrupted by a pale subterminal or terminal patch between veins M_3 and Cu_2; cilia ochreous at base, whitish distally with central fuscous or reddish line. Under side whitish ochreous; a slightly waved, reddish, postmedial line in both wings, the area beyond being heavily suffused with reddish and containing a black subterminal fascia between M_1 and $2A$ of both wings, the fascia of the hindwing narrowed in the central area.

Female

Head, thorax, and ground colour of forewing light reddish brown to dark reddish brown; transverse lines similar to those in male but dark reddish brown to almost black in colour. Hindwing more heavily suffused with grey and with broader terminal fascia than in male. Under side more heavily suffused with red beyond the postmedial line than male.

Genitalia

Male: Valve broad, costa bent outwards in middle, thence concave to apex; aedeagus cylindrical, slightly curved, short backwardly curved heavily sclerotized thorn just within distal orifice; cornuti in a single band of 12-15 heavily sclerotized associated with numerous lightly sclerotized spines, increasing in size towards distal orifice.

Female: Genital plate deeply cup-shaped; bursa copulatrix nearly symmetrical, ovoid, with signa 3 long and 1 short heavily sclerotized, roughened bands, the short one situated about 2/3 of length of bursa from its mouth; bursa seminalis spirally coiled, heavily sclerotized, less than twice length of bursa copulatrix, with inner surface densely clothed with minute spines.

Expanse

Male: Mean 38.6 mm (range 32.8-43.2).

Female: Mean 40.1 mm (range 35.0-46.8).

Type locality: Europe.

The repository of the type is not known, but it may be in the Hofmuseum, Vienna.

Specimens examined: 25 ♂, 45 ♀.

QUEENSLAND: Atherton, Mar. 1903, A.B.B., 2 ♀; 20.i.1904, A.B.B., 1 ♀ (both Nat. Mus.). Biloela, Dec. 1936, W.J.S.S., 1 ♀; Jan.-Mar. 1937, W.J.S.S., 2 ♂, 2 ♀ (pupae ex maize field); Feb. 1937, Apr. 1937, Jan. 1938, W.J.S.S., 3 ♂, 2 ♀ (pupae ex sorghum field); Jan. 1937, 3.i.1937, and Feb. 1937, W.J.S.S., 3 ♂ (reared on *Trianthema portulacastrum*); Jan.-Mar. 1937, W.J.S.S., 3 ♂, 1 ♀ (pupae ex cotton field); Jan. and Mar. 1937, W.J.S.S., 2 ♀ (reared on cotton leaves); Jan. 1938, W.J.S.S., 1 ♂ (all Qld. Dept. Agric.). Brisbane, R. Illidge, 2 ♀ (S. Aust. Mus.); Nov., 1 ♀; 22.i.1903, 1 ♂, 1 ♀; 16.ii.1903, 1 ♀ (all C.S.I.R.O.); 24.iii.1903, 1 ♂ (Aust. Mus.); 21.x.1907, 1 ♀ (C.S.I.R.O.); Oct. 1912, T. P. Lucas, 1 ♀ (S. Aust. Mus.); 5.x.1925, H. Hacker, 1 ♀ (Qld. Mus.); 16.x.1929, 1 ♀ (C.S.I.R.O.); 20.viii.1946, H.J., 1 ♀ (Qld. Dept. Agric.). Burdekin Valley, 8-11.i.1953, A. V. Hill and D. Wark, 2 ♂, 1 ♀ (ex tobacco) (C.S.I.R.O.). Cape York, 8.v.1928, W. B. Barnard, 1 ♂ (Qld. Mus.). Cunnamulla, 16.x.1940, N. Geary, 2 ♀ (Aust. Mus.). Gordonvale, 15.iv.?, 1 ♂ (Fig. 2*B*) (C.S.I.R.O.). Herbert River, Aug. 1911, 1 ♀ (Aust. Mus.). Home Hill, 18.xi.1948, W. A. Smith, 1 ♀ (ex cotton) (Qld. Dept. Agric.). Meringa, 2.v.1929, E.J., 1 ♀ (Nat. Mus.). Montville, 14.iii.1920, 1 ♀ (Fig. 3*B*) (C.S.I.R.O.). Mossman, Sept. 1911, 1 ♀; Jan. 1912, 1 ♂ (both Aust. Mus.). Rockhampton, 12.viii.1952, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Sunnybank, 19.viii.1952, I. F. B. Common, 1 ♀ (C.S.I.R.O.). Toowoomba, 28.iv.1924, W. B. Barnard, 1 ♀ (Qld. Mus.). Wellington Point, Dec. 1944, J.H.S., 1 ♂ (ex maize) (Qld. Dept. Agric.).

NEW SOUTH WALES: Bellbrook, 17.iii.1941, 1 ♂ (ex lucerne) (N.S.W. Dept. Agric.). Clarence River, 1 ♀ (C.S.I.R.O.). Deewhy, Feb. 1928, M. Fuller, 1 ♀ (C.S.I.R.O.). Gin Gin, 23.x.1952, L. Chinnick, 1 ♂ (light trap) (C.S.I.R.O.). Maitland, 14.iii.1950, G. Pasfield, 1 ♀ (ex cabbage) (N.S.W. Dept. Agric.). Sydney, 1 ♀ (C.S.I.R.O.); 1 ♀; 1907, 1 ♀; A. S. Olliff, 1 ♀ (all Aust. Mus.); 14.iv.1910, G. Lyell, 1 ♀ (Nat. Mus.); 22.ii.1926, 1 ♀ (Aust. Mus.); 3-11.xi.1936, ex peas, 1 ♂, 2 ♀ (N.S.W. Dept. Agric.).

AUSTRALIAN CAPITAL TERRITORY: Canberra, 8.ii.1953, I. F. B. Common, 1 ♀ (light trap) (C.S.I.R.O.).

SOUTH AUSTRALIA: Dr. Pooler, 1 ♂; Balhannah, E. Guest, 1 ♀; Parkside, 1 ♀ (all S. Aust. Mus.).

Comments

Specimens of *H. armigera* from New Zealand, Fiji, and India have also been examined. In addition, D. S. Fletcher has examined a series of specimens in the British Museum from Australia, Africa, and Europe on behalf of the writer.

The males can usually be distinguished from *H. punctigera* by the more distinct markings of the forewings; the light patch in the black fascia of the hindwings is usually distinct, whereas it is rarely present and then in a very indistinct form in males of *H. punctigera*; the genitalia of the 2 species are very distinct, the valve being broad in *H. armigera* but very narrow in *H. punctigera* and the inner sclerotized process of the aedeagus is thorn-like in *H. armigera* but in the form of a long spine in *H. punctigera*; the cornuti are larger in *H. armigera* and the valve much broader than in any of the other Australian species. *H. umbrosus* lacks the thorn-like process of the aedeagus and has a larger number of cornuti, in 2 bands. The aedeagus in *H. umbrosus* is distinctly longer than the greatest length of the valve (Fig. 4*A, B*) whereas in *H. armigera* they are of approximately equal length.

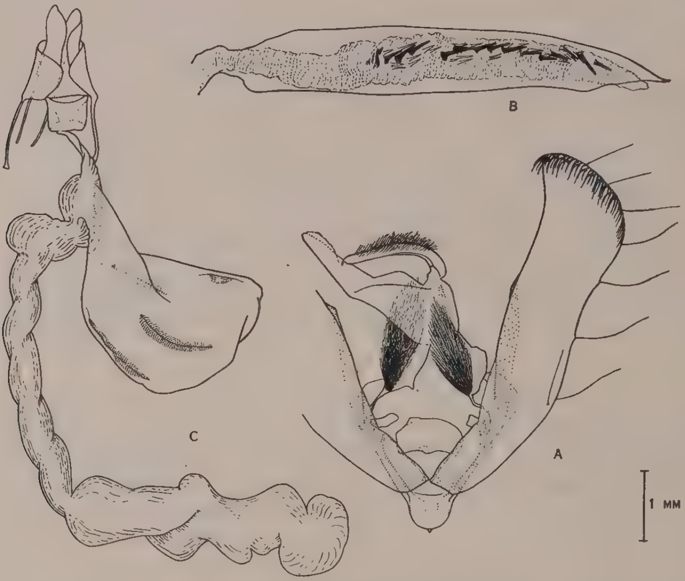


Fig. 4.—Genitalia of specimens of *Heliothis* from North America, probably *H. umbrosus* Grote. *A* and *B*, male, Grimsby, East Ontario, 18.ix.1931, A. Gibson; *C*, female, Imperial Valley, California, Mar. 1914, J. Sinclair (camera lucida).

In the female, the reddish brown ground colour of the forewing separates it from *H. assulta* and the distinct markings separate it from *H. punctigera*; the light patch in the fascia of the hindwing distinguishes it from *H. punctigera* and *H. rubrescens*; the greyish suffusion of the hindwing distinguishes it from *H. assulta* and *H. rubrescens*; and the very marked reddish suffusion of the outer ½ of the under side of the hindwing separates it from *H. assulta* and *H. punctigera*. It may be separated from *H. assulta* and *H. rubrescens*, and also from *H. umbrosus*, by the clothing of minute spines in the bursa seminalis. In *H. armigera* the bursa seminalis is less than twice the length of bursa copulatrix, whereas in *H. umbrosus* it is more than twice the length of bursa copulatrix (Fig. 4*C*). The spiral coiling of the bursa seminalis separates it from *H. rubrescens* and the deeply cup-shaped genital plate and symmetrical bursa copulatrix separate it from *H. punctigera*, in which the genital plate is parallel-sided and the bursa copulatrix asymmetrical.

Two rather aberrant female specimens from Cunnamulla in the Australian Museum collection have pale ochreous forewings and ill-defined terminal fasciae in the hindwings. One of these is lightly suffused with pale pink. However, the transverse markings of the forewings, though pale, are typical of *H. armigera,* the pale patch in the terminal fasciae of the hindwings is present, and the genitalia are normal.

HELIOTHIS PUNCTIGERA Wallengren

Figs. 2*C*, 3*C;* Plate 1, Figs. 7-10

Heliothis punctigera Wallengren, 1860, Wien. ent. Montschr. **4**: 171-2. 1861, Kong. Svensk. Freg. Eug. **2** Zool. 1, Insecta, p. 375.

Male

Head and thorax pale ochreous; legs pale ochreous, tibiae rosy tinged; abdomen pale greyish ochreous. Forewing pale ochreous with indistinct markings; sub-basal, antemedial, and medial lines absent; postmedial line very indistinct, slightly dentate; subterminal line indistinct, angled outwards on R_5, slightly convex from M_2 to near tornus; area between postmedial and subterminal lines slightly suffused with grey and with a transverse row of minute fuscous dots, each associated with a few orange scales; orbicular and reniform indistinct; a series of minute, black, terminal dots; cilia pale pinkish orange. Hindwings whitish, veins marked with black scales, sometimes with slight grey suffusion towards base, and a broad black terminal fascia narrowing towards costa and tornus, almost invariably without any pale patch between veins M_3 and Cu_2; cilia white. Under side whitish; forewing with indistinct orbicular and well-defined black reniform and black, curved, subterminal fascia between veins M_1 and $2A$; hindwing with subquadrate marginal fascia between M_1 and $2A$.

Female

Head and thorax light brown; legs pale greyish ochreous, tibiae rosy tinged; abdomen greyish ochreous. Forewing ochreous-brown to dark greyish brown, sometimes suffused with reddish, with indistinct markings; sub-basal line absent; antemedial line absent or very indistinct; medial line curved outwards at Cu; postmedial line indistinct and slightly dentate; subterminal line very indistinct, as in male; area between postmedial and subterminal lines darker, with a transverse series of minute black dots, sometimes associated with a series of white dots; orbicular and reniform indistinct; a series of minute black, terminal dots; cilia ochreous orange. Hindwing whitish, suffused with grey, especially towards dorsum, and with veins outlined with black scales; a broad black terminal fascia, narrowing slightly towards costa and tornus, never with pale marginal patch between M_3 and Cu_2. Under side whitish, suffused with pinkish grey towards apex of each wing, orbicular usually indistinct, reniform well defined, fuscous; forewing with curved subterminal fascia; hindwing with subquadrate marginal fascia as in male.

Genitalia

Male: Valve long and narrow, costa concave and sharply curved towards apex; aedeagus cylindrical, proximal orifice very oblique, a long, backwardly directed, heavily sclerotized spine just within the distal orifice; cornuti a band of about 72 heavily sclerotized (occasionally lightly sclerotized) spines, increasing in size distally.

Female: Genital plate parallel-sided; bursa copulatrix asymmetrical, tapering to a rounded point on the side remote from the bursa seminalis, signa 1 small and 3 longer heavily sclerotized roughened bands, the smallest signum situated near the rounded point of bursa; bursa seminalis coiled in a loose spiral, more than twice length of bursa copulatrix, with inner surface densely clothed with minute spines.

Expanse

Male: 37.5 mm (range 29.0-43.2).

Female: 37.4 mm (range 31.2-42.4).

Type locality: "Sidney, New Holland."

Type in the Naturhistoriska Riksmuseum, Stockholm, Sweden.

Specimens examined: 115 ♂, 150 ♀.

QUEENSLAND: Biloela, 4.i.1937, W.J.S.S., 1 ♀ (ex *Trianthema portulacastrum*) (Qld. Dept. Agric.). Brisbane, R. Illidge, 1 ♀ (S. Aust. Mus.); Jan., 1 ♀; Nov., 1 ♂, 1 ♀; 1.x.1902, 1 ♀; 23.iv.1903, 1 ♂ (all C.S.I.R.O.); Dec. 1910, 1 ♀; Nov. 1911, T. P. Lucas, 1 ♀ (both S. Aust. Mus.); 27.x.1935, H. Hacker, 1 ♀ (at light) (Qld. Dept. Agric.). Brookstead, Oct. 1951, T. Passlow, 1 ♂, 1 ♀ (ex linseed) (Qld. Dept. Agric.). Carnarvon Range, Feb. 1944, N. Geary, 1 ♀ (Aust. Mus.). Charleville, 9.ix.1920, 1 ♂ (C.S.I.R.O.). Cunnamulla, N. Geary, 1 ♀; 9.iv.1940, N. Geary, 1 ♂; 17.x.1940, N. Geary, 1 ♀; Nov. 1942, N. Geary, 1 ♂; Jan. 1943, N. Geary, 1 ♂, 1 ♀; Feb. 1943, N. Geary, 1 ♀ (all Aust. Mus.). Darling Downs, A. W. S. May, 2 ♂ (ex linseed) (Qld. Dept. Agric.). Eidsvold, 1 ♀; Oct. 1926, Mackerras, 1 ♀ (both C.S.I.R.O.). Gayndah, 1 ♂ (C.S.I.R.O.). Hughenden, 10.vi.1935, 1 ♀ (C.S.I.R.O.). Milmerran, 4, 21.ix.1927, J. Macqueen, 2 ♂ (Nat. Mus.). Southport, 15.ii.1903, 1 ♂ (C.S.I.R.O.). Toowoomba, 5.x.1919, 1 ♂; 21.ix.1921, 1 ♀ (both Qld. Mus.). Westwood, 3.i.1924 to 29.ii.1924, A.N.B., 1 ♂, 3 ♀ (Nat. Mus.).

NEW SOUTH WALES: Boambee, 11.xii.1939, C. R. Wallace, 1 ♀ (N.S.W. Dept. Agric.). Broken Hill, 1 ♂, 1 ♀ (S. Aust. Mus.). Clovelly, 16-22.ix.1952, W. E. Wright, 3 ♂, 4 ♀ (at electric light) (N.S.W. Dept. Agric.). Gundagai, 4.iii.1941, C. R. Wallace, 3 ♂ (ex lucerne) (N.S.W. Dept. Agric.). Leeton, 12.xii.1939, 2 ♀ (ex linseed) (N.S.W. Dept. Agric.). Lismore, 23.xi.1936, 1 ♀ (N.S.W. Dept. Agric.). Murrumbidgee Irrigation Area, 27.x.1927, 1 ♂ (on prunes) (N.S.W. Dept. Agric.). 20 miles N. of Murrurundi, 2.iv.1952, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Narara, 30.xi.1946, A.B., 1 ♀ (Nat. Mus.). 65 miles NW. of Nyngan, 22.x.1949, I. F. B. Common, 1 ♀ (C.S.I.R.O.). Sutherland, Woronora R., 28.xi.1920, A. Musgrave, 1 ♂ (Aust. Mus.). Sydney, 1 ♂ (the holotype) (Naturhistoriska Riksmuseum, Stockholm); 1 ♀ (Fig. 3C) (C.S.I.R.O.); Nov. 1913, 1 ♂; Nov. 1920, 1 ♂, 1 ♀; 24.i.1920 and 12.xii.1920, L. B. Thorn, 1 ♂, 1 ♀ (all Aust. Mus.); 22.xii.1936, A. J. Nicholson, 1 ♀ (ex peas) (C.S.I.R.O.); 19.ix.1938, N.L., 1 ♂; 21.i.1952, L. Pratt, 1 ♂ (N.S.W. Dept. Agric.). Trangie, 12.ix.1952, 31.x.1952, and 2.xi.1952, B. Cameron, 1 ♂, 2 ♀ (light trap) (C.S.I.R.O.). Between Wauchope and Maitland, Dec. 1940, 1 ♂ (ex lucerne) (N.S.W. Dept. Agric.). Yanco, 26.ix. to 26.x.1932, K. C. McKeown, 1 ♀ (Aust. Mus.). Young, 27.x.1927, 1 ♀ (on cherries) (N.S.W. Dept. Agric.).

AUSTRALIAN CAPITAL TERRITORY: Canberra, 1.ii.1930, G. A. Currie, 1 ♂; 12.ii.1930, G. A. Currie, 1 ♀ (ex tobacco); Jan. 1931, G. A. Currie, 1 ♀ (ex *Hypericum perforatum*); 3.ii.1953, I. F. B. Common, 1 ♂ (ex *Antirrhinum*); 7.iii.1953, I. F. B. Common, 1 ♂ (ex tomato); 6-9.ii.1953, I. F. B. Common, 5 ♂, 3 ♀ (reared on *Calendula* ex eggs from ♀ ♀ in light trap); 6.xi.1952 to 7.i.1953, I. F. B. Common, 26 ♂, 31 ♀ (light trap); 1.iii.1953, I. F. B. Common, 1 ♀ (light trap) (all C.S.I.R.O.).

VICTORIA: Cowes, 6.ii.1947, R.P., 1 ♂, 1 ♀ (Nat. Mus.). Daytrap, 15.x.1919, R.McD., 1 ♂, 1 ♀ (Nat. Mus.). Dimboola, 14.xi.1903, 1 ♀ (Nat. Mus.). Gisborne, 23.xii.1894, 2 ♂; 4.ii.1897, 1 ♀; 21.iii.1897, 1 ♀ (all Nat. Mus.); 10.i.1898, 1 ♀; 21.i.1902, 1 ♀ (both C.S.I.R.O.); 10.xi.1903; 1 ♂, 6 ♀; 5.ii.1913, 1 ♂; 15.xii.1916, 3 ♂, 2 ♀; 23.ix.1919, 1 ♀; 1.xi.1919, 1 ♂; 16.xi.1928, 1 ♀; 29.i.1929, 1 ♀ (all Nat. Mus.).

TASMANIA: Bushy Park, 3.iii.1937, J. W. Evans, 2 ♀ (ex tobacco) (Tas. Dept. Agric.). Launceston, 1 ♀ (S. Aust. Mus.). Wynyard, 27.i.1916, G. H. Hardy, 1 ♂ (Aust. Mus.).

SOUTH AUSTRALIA: Rev. A. P. Burgess, 2 ♀ (S. Aust. Mus.). Adelaide, 1 ♂, 1 ♀ (S. Aust. Mus.); 6.xii.1937, D.C.S., 1 ♂, 1 ♀; Dec. 1937, D.C.S., 1 ♂; Oct. 1944, 1 ♂ (reared from larva attacking flax); Sept. 1945, 1 ♀; 24.x.1945, 1 ♀ (at light); Feb. 1949, 3 ♂, 1 ♀ (at light); 22.ix.1950, 3 ♂, 3 ♀ (at light); 29.xi.1950, 1 ♀ (larva on flax); 17.i.1951, 1 ♂ (larva eating rose buds); 29.i.1951, 1 ♀ (larva on flax); 19.xii.1952, H.F.L., 1 ♂, 8 ♀ (at light); 23.xii.1952, H.F.L., 1 ♀; 13.i.1953, H.F.L., 2 ♂, 3 ♀ (at light); 15.i.1953, 1 ♂ (all Waite Inst.). Ardrossan, 5.i.1951, H. M. Cane, 1 ♂ (C.S.I.R.O.). Basket Range, 5.xii.1945, B. E. Coombe, 1 ♀ (Waite Inst.). Gulnare, 14.ix.1950 2 ♂ (Waite Inst.). Parkside, 1 ♂, 1 ♀ (S. Aust. Mus.). Port Lincoln, Jan. 1928, N. B. Tindale, 1 ♂ (S. Aust. Mus.). Woodside, 6.i.1892, 1 ♀ (S. Aust. Mus.). Yankalilla, 26.ix.1950, D.C.S., 2 ♂, 4 ♀ (flying in sunlight in pasture) (Waite Inst.).

WESTERN AUSTRALIA: Applecross, Feb. 1951, W. M. O'Donnell, 1 ♀ (W.A. Dept. Agric.). 10 miles S. of Bridgetown, 2.x.1951, I. F. B. Common, 2 ♂ (C.S.I.R.O.). Carnarvon, Booloogroo Stn., July 1948, A. Snell, 1 ♂; Yalbalgo Stn., Aug. 1949, A. Snell, 1 ♂ (all W.A. Dept. Agric.). Collie Cardiff, 15-17.xi.1927, 1 ♂, 1 ♀ (Nat. Mus.). Darlington, 28.xii.1948, C. F. H. Jenkins, 3 ♂, 3 ♀ (W.A. Dept. Agric.). Derby, 1.ix.1929, I. M. Mackerras and T. G. Campbell, 1 ♂, 1 ♀ (C.S.I.R.O.). Fremantle, 16.ii.1934, K. R. Norris, 1 ♀ (C.S.I.R.O.); 13.xii.1949, C. F. H. Jenkins, 1 ♂, 2 ♀ (W.A. Dept. Agric.). Halls Creek, 14.v.1944, C. F. H. Jenkins, 1 ♂, 1 ♀ (W.A. Dept. Agric.). Kalgoorlie, 23.x.1946, 2 ♀ (W.A. Dept. Agric.). Katanning, 10.x.1951, I. F. B. Common, 1 ♀ (C.S.I.R.O.). Kimberley Research Station, 11.ii.1952, R. Lukins, 2 ♂ (W.A. Dept. Agric.). Nedlands, 10.xi.1939, P. N. Forte, 1 ♀ (at light)

(W.A. Dept. Agric.); 5.xii.1952, J. A. Mahon, 1 ♀ (light trap) (C.S.I.R.O.). Perth, 23.xi.1938, 1 ♂ (C.S.I.R.O). Roebourne, Warambie Stn., 15.v.1949, A. Snell, 1 ♀ (W.A. Dept. Agric.). Rottnest I., 21.iii.1934, K. R. Norris, 1 ♂ (C.S.I.R.O.). Scarborough, 22.ix.1951, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Waroona, 25.ii.1909, G. F. Berthoud, 1 ♀ (Nat. Mus.); 25.x.1938, 1 ♀ (C.S.I.R.O.). Wyndham, 8, 28.xii.1929 and 6.i.1930, T. G. Campbell, 1 ♂, 2 ♀ (C.S.I.R.O.). Yalgoo, Boolardy Stn., Oct. 1949, A. Snell, 1 ♀ (W.A. Dept. Agric.). Yampi Sound, 18.xi.1945, J. O. Campbell, 1 ♀ (Aust. Mus.).

NORTHERN TERRITORY: Macdonnell Ranges, Capt. S. A. White, 1 ♂, 1 ♀ (S. Aust. Mus.). Newcastle Waters, 6.vi.1929 and 2.vii.1929, T. G. Campbell, 2 ♀ (C.S.I.R.O.).

The author has also examined a specimen from Cocos I.

Comments

The species is most easily recognized by the pale ochreous forewings of the male, and in both sexes by the indistinct markings of the forewing, the uninterrupted black terminal fascia and whitish basal area of the hindwing, and the black quadrate spot on the under side of the hindwing. The male genitalia are most easily distinguished from those of other species by the long, backwardly directed spine within the distal orifice of the aedeagus, and the female genitalia by the asymmetrical bursa copulatrix and parallel-sided ostium.

This species has previously been confused with *H. armigera* both in the literature and in collections, and the extensive economic losses caused by its larvae have been attributed to *H. armigera*.

HELIOTHIS RUBRESCENS (Walker)

Figs. 2*D*, 3*D*; Plate 1, Figs. 11-14

Thalpophila rubrescens Walker, 1858, List Lep. Ins. Coll. Brit. Mus. **15**: 1681.
Chloridea aresca Turner, 1911, Ann. Qd. Mus. **10**: 60 (type locality: Toowoomba).
Heliothis hyperchroa Turner, 1920, Trans. Roy. Soc. S. Aust. **44**: 131 (type locality: Stanthorpe, Lawson, or Tasmania).

Male, normal form

Head and thorax grey, labial palpi ochreous, suffused with reddish, antennae reddish towards base; legs ochreous grey, suffused with reddish, anterior and middle tarsi also suffused with fuscous; abdomen ochreous grey, suffused with reddish on the under side. Forewing ochreous grey, irrorated with reddish on costa, markings reddish brown, sometimes indistinct; sub-basal line outwardly oblique from costa near base, extending 1/3 of distance across wing; antemedial line angled outwards near costa, and again below cell and near dorsum; medial line indistinct, angled outwards to end of cell, then inwardly oblique to ½ dorsum, with 1 dentation near dorsum; postmedial line gently convex and acutely dentate, the dentations ending in a series of fuscous dots suffused with reddish; subterminal line represented by a row of dots between the veins; terminal series of minute black dots; orbicular and reniform distinct, with fuscous centres and surrounded by reddish brown quadrangles; cilia reddish at base, fuscous distally.

Hindwings ochreous with a dull black terminal fascia, narrowing towards costa and tornus, with some reddish irroration on termen; cilia pale ochreous mixed with reddish scales. Under side pale ochreous; forewing with orbicular absent, reniform crescentic, indistinct; both wings beyond postmedial line reddish, with curved, black, subterminal fascia on forewing between veins M_1 and $2A$ and a black, subquadrate, terminal blotch on hindwing between veins M_2 and $2A$.

Female, normal form

Head, thorax, and ground colour of forewing dark reddish brown, with dark red suffusion at base of antennae, on labial palpi, and on legs. Transverse lines on forewing dark brown, somewhat diffused, otherwise similar to male. Hindwing ochreous-orange, terminal fascia broader and blacker than in male; cilia ochreous orange mixed with dark red scales. Under side ground colour ochreous, reddish suffusion and fasciae more distinct than in male.

Male and female, pink form

Head, thorax, greyish pink; labial palpi ochreous, suffused with pink; base of antennae pink; anterior and middle legs pink, hindlegs ochreous, tibiae and tarsi irrorated with pink. Forewing pink (corinthian red of Ridgeway (1912)) with dark pink markings, usually very indistinct but, when indicated, they are similar to those of normal form. Hindwing ochreous with pink scales on veins, terminal fascia as in normal form but duller in colour, with pink suffusion on inner and terminal margins. Under side ochreous, heavily suffused with pink beyond postmedial line, fascia indistinct and reduced in size.

Genitalia

Male: Valve narrow at base, gradually expanding towards apex, costa almost straight in basal ½, but curving strongly near apex. Aedeagus cylindrical, narrower near base, proximal orifice very oblique; backwardly directed, heavily sclerotized, spiny process just within distal orifice; cornuti in a narrow band of numerous, very small, slender spines, vestigial in some specimens.

Female: Genital plate broadly cup-shaped; bursa copulatrix slightly asymmetrical, ovate; signa 3 long and 1 short, heavily sclerotized, roughened ridges, the smallest slightly more than ½ way from mouth of bursa; bursa seminalis moderately sclerotized, not coiled, and inner surface without minute spines.

Expanse

Normal form: Male, mean 34.5 mm (range 30.0-38.4). Female, mean 35.9 mm (range 33.0-40.4).

Pink form: Male, mean 33.8 mm (range 33.4-34.0). Female, mean 33.7 mm (range 30.0-36.0).

Type locality: Moreton Bay (Queensland).

Type in British Museum (Natural History).

Specimens examined: 48 ♂, 35 ♀.

Normal form.—QUEENSLAND: 1 ♂ (S. Aust. Mus.); Blackbutt, 24-27.iv.1914, 1 ♀ (Aust. Mus.). Brisbane, H. Hacker, 1 ♂ (Qld. Mus.); F. P. Dodd, 1 ♂, 1 ♀ (Nat. Mus.); 2 ♂ (Lucas Coll.); R. Illidge, 1 ♀ (both S. Aust. Mus.);

Jan., 1 ♀; 24.vi.1903, 1 ♀; 13.ix.1903, 1 ♀ (Fig. 3*D*) (all C.S.I.R.O.); 4.i.1905, 1 ♂ (Nat. Mus.); Oct. 1916, T. P. Lucas, 1 ♂ (S. Aust. Mus.); 16.ix.1919, 1 ♂; 6.iv.1929, 1 ♂; 8.v.1933, 1 ♂; 7.vii.1942, 1 ♂ (all C.S.I.R.O.). Bunya Mt., 3500 ft, 26.ii.1931, 1 ♂ (C.S.I.R.O.); 18.ii.1940, 1 ♂; 25.ii.1940, 1 ♂ (both Qld. Mus.). Carnarvon Range, Feb. 1944, N. Geary, 1 ♀ (Aust. Mus.). Clermont, K. K. Spence, 2 ♀ (Aust. Mus.). Lamington National Park, 3000 ft, 4-17.iii.1929, 5 ♂ (C.S.I.R.O.). Millaa Millaa, 6-11.xi.1929, 1 ♀ (C.S.I.R.O.). Milmerran, 1.i.1929, J. Macqueen, 1 ♀ (Nat. Mus.). Rockhampton, 28-30.vii.1952, I. F. B. Common, 3 ♀ (C.S.I.R.O.). Tamborine Mt., 13.iii.1944, 2 ♀ (C.S.I.R.O.). Toowoomba, 17.iv.1905, 1 ♂ (type of *Chloridea aresca* Turn.) (Fig. 2*D*) (C.S.I.R.O.); 11.iii.1928, 1 ♂; 7.v.1929, 1 ♂, W. B. Barnard (both Qld. Mus.).

NEW SOUTH WALES: Barrington Tops, Feb. 1925, S.U. Zoo. Exp., 1 ♂ (Aust. Mus.). Gin Gin, 25.x.1952, L. Chinnick, 1 ♂ (light trap) (C.S.I.R.O.). Narara, 14-17.iii.1945, L. H. Moss-Robinson, 2 ♀ (C.S.I.R.O.). Narrabeen, 10.ii.1928, 1 ♂ (Aust. Mus.). Sydney, 1 ♂ (C.S.I.R.O.); Dec. 1911, G. M. Goldfinch, 1 ♂; 27.xi.1912, 1 ♀; 17.x.1912, 1 ♂; 27.ix.1919, G. M. Goldfinch, 1 ♂ (all Aust. Mus.); 16.iv.1952, W. E. Wright, 1 ♀ (at light) (N.S.W. Dept. Agric.). Trangie, 9.ix.1952, B. Cameron, 1 ♂ (light trap) (C.S.I.R.O.). Williams River, near Cutler's Pass, 1250 ft, Jan. 1943, B. Mesmer, 1 ♀ (Aust. Mus.). Woodford, 17.xii.1927, G. M. Goldfinch, 2 ♂, 1 ♀ (Aust. Mus.).

AUSTRALIAN CAPITAL TERRITORY: Canberra, 10.ix.1950, 3.x.1951, 15.ix.1952, 21.ix.1952, 8.x.1952, 20.xi.1952, 22.ii.1953, 5.iii.1953, 8.iii.1953, I. F. B. Common, 4 ♂, 8 ♀ (light trap) (all C.S.I.R.O.).

TASMANIA: Strahan, 17.xi.1899, 1 ♂ (Tas. Dept. Agric.).

SOUTH AUSTRALIA: Parkside, 1 ♂ (S. Aust. Mus.).

WESTERN AUSTRALIA: 10 miles S. of Bridgetown, 2.x.1951, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Carnarvon, Booloogroo Station, July 1948, A. Snell, 1 ♂; Lyndon Station, 30.vi.1949, A Snell, 1 ♂; Lyons Station, 25.viii.1948, A. Snell, 1 ♂; Yalbalgo Station, Aug. 1949, A. Snell, 1 ♀ (all W.A. Dept. Agric.). Katanning, 10.x.1951, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Nedlands, 25.ix.1951, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Stirling Range, 7.x.1951, I. F. B. Common, 1 ♂ (C.S.I.R.O.). Tammin, 2.x.1938, 1 ♂ (C.S.I.R.O.). Waroona, 21.xii.1907 and 11.i.1908, G. F. Berthoud, 2 ♀; March 1928, G.R.B., 2 ♀ (all Nat. Mus.). Yelbeni, Sept., B. A. O'Connor, 1 ♂ (W.A. Dept. Agric.).

NORTHERN TERRITORY: Mt. Squire, Aug. 1891, Helms, 1 ♂ (Elder Expedition) (S. Aust. Mus.).

2 ♂, 20 ♀.

Pink form.—QUEENSLAND: Brisbane, Nov., 1 ♀; 29.viii.1936, 1 ♂ (both C.S.I.R.O.). Cunnamulla, 6.ix.1940, N. Geary, 1 ♀ (Aust. Mus.). Tamborine Mt., 4.xii.1934, E. J. Dumigan, 1 ♀ (C.S.I.R.O.). Toowoomba, 21.ix.1921, W. B. Barnard, 1 ♀ (Qld. Mus.); 27.iv.1924, W. B. Barnard, 1 ♀ (Qld. Dept. Agric.).

NEW SOUTH WALES: Trangie, 3.ix.1952, I. F. B. Common, 2 ♀; 13.ix.1952, B. Cameron, 1 ♀ (light trap) (all C.S.I.R.O.).

AUSTRALIAN CAPITAL TERRITORY: Canberra, 29.x.1951, 16.x.1952, I. F. B. Common, 2 ♀ (light trap) (all C.S.I.R.O.).

VICTORIA: Beaconsfield, Sept. 1903, 1 ♀ (Drake Coll.) (Nat. Mus.).

TASMANIA: Launceston, 1 ♀ (S. Aust. Mus.). Snug R., 1925, I. Harman, 1 ♂ (Nat. Mus.). Ulverstone, Mrs. Lodger, 1 ♀ (Nat. Mus.).

SOUTH AUSTRALIA: Rev. A. P. Burgess, 1 ♀ (S. Aust. Mus.). North-west of South Australia, H. Basedow, 1 ♀ (S. Aust. Mus.). Parkside, 1 ♀ (S. Aust. Mus.).

WESTERN AUSTRALIA: Carnarvon, Lyndon Station, 30.vi.1949, A. Snell, 1 ♀; Yalbalgo Station, Aug. 1949, A. Snell, 1 ♀ (both W.A. Dept. Agric.). Nedlands, 20, 25.ix.1951, I. F. B. Common, 2 ♀ (C.S.I.R.O.).

Comments

The male is distinguished from the other Australian species by the ochreous grey forewing and acutely dentate postmedial line. The reddish suffusion beyond the postmedial line on the under side of both wings separates both sexes from *H. assulta* and *H. punctigera*. *H. rubrescens* lacks the pale patch in the black terminal fascia of the hindwing which is present in both sexes of *H. armigera*. The normal female of *H. rubrescens* is most like the female of *H. armigera*, but the basal ½ of the hindwing is ochreous-orange and is not suffused with grey. The narrow base and broad, curved, apical part of the male valve, and the spiny process near the distal orifice of the aedeagus, distinguish it from the other Australian species. The ovate bursa copulatrix and the uncoiled bursa seminalis separate the female.

The pink form of *H. rubrescens* is a very distinctive insect, but the genitalia do not appear to differ from the normal form. In most Australian collections it has previously appeared under the name *H. armigera*.

THE PEST STATUS OF HELIOTHIS IN AUSTRALIA

Damage by *Heliothis* to economic crop plants has been recorded in every State of the Commonwealth and hitherto it was believed that *H. armigera* alone was responsible. From the above it will be clear that a second species, *H. punctigera*, is also concerned. As the distribution of the two species in Australia is fairly well defined (Fig. 1), it is possible to deduce from the literature and from the host records of reared specimens the host range and the probable pest status of the two species.

In the first place, it is probable that *H. punctigera* alone is responsible for economic damage in Tasmania, Victoria, South Australia, Western Australia, and the Northern Territory. There appears to be no detailed information on the ecology of this species. Apparently *H. punctigera* is not a serious pest in Tasmania, where the most important economic host is tomato (Evans 1943; Miller 1945), although it has also been reared from tobacco grown in the Derwent Valley. There are few references to injurious attacks in Victoria, where at times it is a serious pest of tomatoes. Pescott (1940) stated that losses of up to 50 per cent. of the crop may be incurred and several generations may be completed each year. Lucerne, tobacco, and field peas are probably also damaged at times.

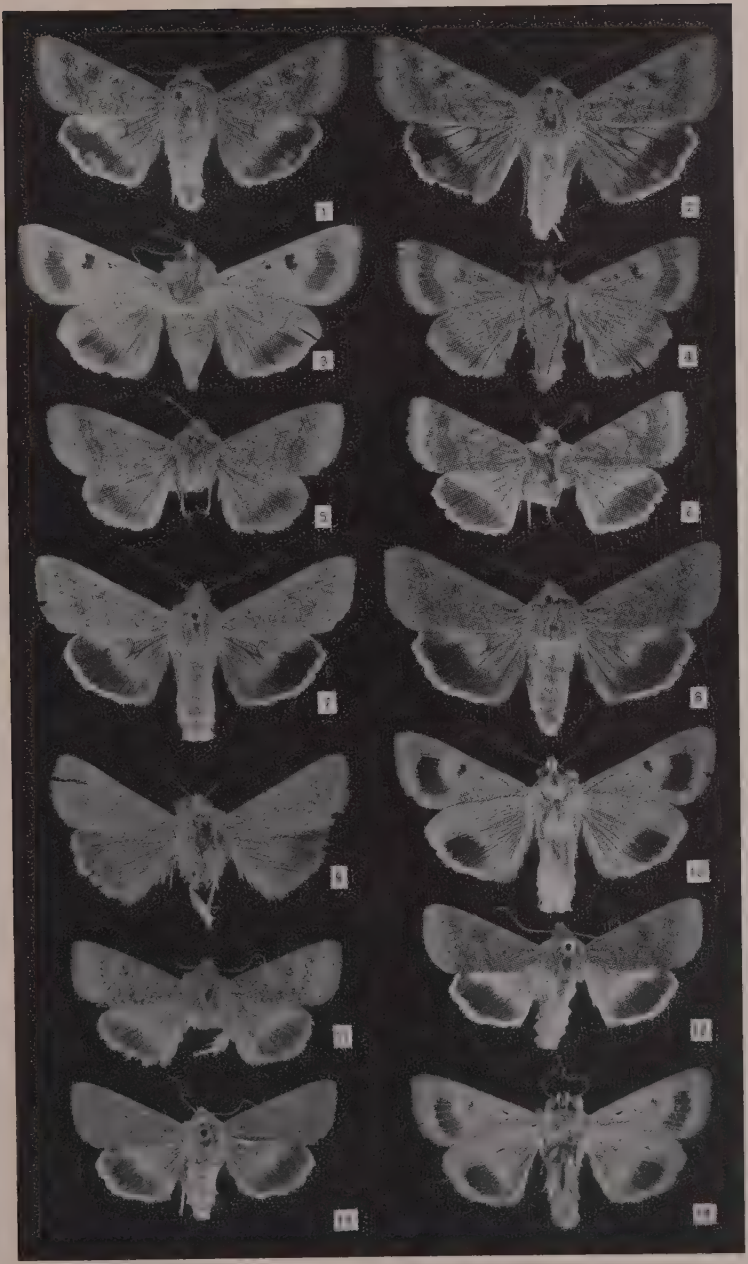
Three specimens of *H. armigera* reputed to be from South Australia are in the South Australian Museum. They bear no collecting dates, but were probably collected more than 50 years ago. A long series of specimens in the collection of the Waite Agricultural Research Institute, collected and reared in recent years from economic hosts in South Australia is without exception *H. punctigera*. Further rearing and critical identification are necessary, of course, to determine if *H. armigera* is ever a pest in that State.

Quinn (1910) stated that grubby tomatoes were very noticeable in South Australia in the 1910 season, both in the field and in the markets. The pest responsible for this injury he believed to be *H. armigera*, but it seems more likely that *H. punctigera* was the species concerned. Lea (1928) gave an account of *Heliothis* in South Australia, but drew freely upon bionomic data from the United States literature, reproducing illustrations of what is probably *H. umbrosus*. It is difficult therefore to decide how much of his information applied to the local species. However, he made certain interesting and useful observations. He stated that in South Australia *Heliothis* has several hosts but is chiefly a pest of lucerne, at times destroying as much as 80 per cent. of a crop. Twice in South Australia and once in Western Australia he had observed thousands of *Heliothis* larvae feeding completely exposed on the flowers of everlasting daisies. In Western Australia, near Champion Bay, the everlastings dried off before the larvae had reached maturity and they then invaded and seriously injured adjacent fields of oats. As *H. punctigera* is undoubtedly indigenous, Lea's account is all the more important because it is the only published record of native host plants. Recently, C. E. Chadwick (personal communication) collected a single *Heliothis* larva, possibly *H. punctigera*, feeding on the flower of a native composite at Mt. Kosciusko.

Lea also reported that *Heliothis* at times damages apples in South Australia, the leaves and terminal shoots being devoured and the fruit tunnelled. A severe attack may seriously check the affected trees but fortunately this is not common. Davidson (1931) described similar injury to apples. Specimens of *H. punctigera* reared from larvae attacking linseed by officers of the Waite Institute have also been examined.

In Western Australia, Newman (1911) reported that *H. armigera* was very destructive to maize, peas, and tomatoes and he believed that damage was increasing annually. He inferred that this observation supported his statement that the pest was introduced when, in fact, it could equally well be explained in terms of the rapidly expanding cultivation of crops attractive to an omnivorous native insect, *H. punctigera*. In 1912, Newman added beans and orchard fruits to his list of crops attacked. Again there was evidence that the early spring generation was the most destructive (Stoward 1913). In the 1913-14 season, *Heliothis* caused widespread damage to early tomatoes, and to maize, fruit, and flowers. Losses in orchards were caused by the larvae boring into the immature fruits (Newman 1914). No further outstanding damage was reported from Western Australia until the spring of the 1924-25

AUSTRALIAN SPECIES OF *HELIOTHIS*



and the 1927-28 seasons, when there were serious outbreaks and much damage was again caused to young fruits, tomatoes, and peas. Clover seed was also seriously injured in some areas (Newman 1925, 1928*a*, 1928*b*). Another plague of *Heliothis* was reported by the Western Australian Department of Agriculture (1946) in October and November 1944, or possibly 1945. Severe injury was caused to young apples, peas, and linseed, and damage to lupins in the Geraldton and Wongan Hills areas was disastrous. Further losses occurred in apple orchards in 1946, but were much lighter than in 1945 (W.A. Department of Agriculture 1948). In the 1949-50 season in Western Australia, injury to lupins, field and canning peas, and linseed was reported. Before DDT came into use for its control, *Heliothis* prevented economic returns from linseed crops in the Avon Valley (W.A. Department of Agriculture 1951).

Curiously enough, in north-western Australia and the Northern Territory, *Heliothis* has not been a very serious pest. When it is realized that *H. punctigera* appears to occur more commonly than *H. armigera* in this area the reason for this relative immunity is more readily understood. *Heliothis* does not appear to be a pest of cotton in the Kimberley area or at Katherine, and it seems therefore that *H. punctigera* does not normally attack this crop. This conclusion is supported by the fact that all the available specimens of *Heliothis* reared from cotton at Biloela, Queensland, have proved to be *H. armigera*, although *H. punctigera* also occurs in the Callide Valley. However, *Heliothis* has been recorded attacking sweet maize, cabbage, tobacco, and tomato in the Northern Territory (Helson 1947), all of which are hosts of *H. punctigera* as well as *H. armigera*. However, further specimens need to be collected and reared in the Northern Territory and north-western Australia.

The pest status of the two species in New South Wales and Queensland, where both occur, is rather more obscure. However, in inland New South Wales it seems clear that *H. punctigera* is the pest species. Only three specimens of *H. armigera* have been collected in this area, two of them in light traps near Trangie and at Canberra, when *H. punctigera* was also collected in very large numbers. These specimens could have been introduced from coastal areas as larvae infesting tomatoes or sweet maize.

In the 1923-24 season, *Heliothis* was first reported attacking fruit in deciduous orchards in New South Wales (N.S.W. Department of Agriculture 1924). Again in the 1927-28 season, considerable damage was caused to prunes, plums, apples, and, to some extent, cherries in the Murrumbidgee Irrigation Area (N.S.W. Department of Agriculture 1929). A similar occurrence in the same area was reported by Wason (1946) and the New South Wales Department of Agriculture (1947), when peaches, apricots, and pome fruits were attacked during late October and early November. The larvae which caused this damage apparently invaded the fruit trees after the burr clover upon which they had been feeding began to mature and dry off. In some instances, therefore, attacks on fruit trees have been caused by mass movements of larvae from alternative hosts, but it is not clear if this is the usual history of attacks on deciduous fruits, or if *H. punctigera* actually oviposits on the fruit trees. Damage to deciduous fruits in the Murrumbidgee Irrigation Area again occurred in October 1950 (N.S.W. Entomological Branch 1951).

In 1947 (Anon.) damage to linseed was reported in the North Western and Central Western Slopes and in the Murrumbidgee Irrigation Area. Allman (1949) stated that *Heliothis* seriously injured linseed crops in these areas where adverse weather conditions had prevented effective applications of DDT. Losses of 25 per cent. or more of the crop was common. The New South Wales Entomological Branch (1951) also reported losses of up to 10 per cent. in some linseed crops in the Murrumbidgee Irrigation Area in October 1950. In some years canning peas have also been severely attacked in inland New South Wales (Allman 1949) and light infestations are of frequent occurrence in the Murrumbidgee Irrigation Area in the spring. Injury to tobacco in the Texas and Ashford areas, and to lucerne crops on the Western Slopes, have also been reported (Allman 1949; N.S.W. Entomological Branch 1950). In lucerne, the foliage and flowers are attacked and damage is most serious in districts in which this crop is grown for seed (N.S.W. Department of Agriculture 1929; Grylls 1950). Specimens reared from linseed and lucerne in inland New South Wales have all been *H. punctigera.*

As both *H. armigera* and *H. punctigera* occur in coastal New South Wales north of Sydney, it is difficult to obtain a clear picture of their relative importance. Many reports of injury to maize have been reported but both species attack this crop. Maize has been recorded as a host of *Heliothis* in Western Australia and the Northern Territory and a specimen of *H. armigera* reared from maize near Brisbane has been examined. References to infestations in tomatoes may be more significant. In New South Wales coastal areas, early crops in the Coff's Harbour district and late crops in the Gosford district are seriously attacked by *Heliothis.* Mid-season or summer crops, either on the coast or elsewhere in the State, are usually only lightly infested, but in exceptional years damage may be extensive (Anon. 1941, 1946). Whereas serious injury to tomatoes appears to be of annual occurrence in the coastal tomato-growing districts, serious losses are experienced in only occasional years away from the coast. The distribution of the two species of *Heliothis* would probably explain this observation, the regular serious infestations in coastal districts being mainly due to *H. armigera,* while the frequent light and periodic severe infestations inland are apparently due to *H. punctigera.* Only the latter species has been reared from tomatoes at Canberra.

In inland New South Wales and in the Australian Capital Territory, the frequent attacks on flowers of ornamental plants such as *Antirrhinum, Calendula,* and carnation are probably due to *H. punctigera,* which has been reared from *Antirrhinum* at Canberra. Reported damage to these flowers in coastal New South Wales may be due to either species (N.S.W. Entomological Branch 1947, 1948, 1951).

Further work is necessary in Queensland to clarify the present confused picture of *Heliothis* host preferences and seasonal importance. The literature is not of much help, *H. armigera* having been blamed for injurious attacks on maize, cotton, tomatoes, tobacco, lucerne, linseed, sorghum, and various vegetable crops such as cabbages (Queensland Department of Agriculture and Stock 1951). From Figure 1, it would seem that *H. punctigera* does not occur in Queensland coastal districts north of Brisbane, but further collecting and rearing are necessary to confirm this. Fortunately, a series of specimens reared from various economic hosts has been available for study. In recent years, linseed has been extensively attacked on the Darling Downs (May 1949; Passlow 1952) and all the specimens reared from this crop have proved to be *H. punctigera,* which is also the species responsible for damage to linseed in New South Wales. Although this species occurs commonly in the Callide Valley, a series of specimens reared from cotton, maize, and sorghum by W. J. S. Sloan have all been *H. armigera.* The latter species has also been reared from black pigweed, *Trianthema portulacastrum* at Biloela, but the series included a single specimen of *H. punctigera* reared from this weed host. However, all these specimens reared from the Callide Valley emerged from pupae in January, February, and March, and further rearing of specimens from cotton and other crops earlier in the season is necessary in this area.

As *H. armigera* has now been distinguished from the North American cotton bollworm, it should not be assumed that *H. armigera* must be a serious cotton pest in Queensland. In fact Husain (1930) and Ayyar (1940) stated that *H. armigera* is not a pest of cotton in India, its major economic host being a legume, the red gram (*Cajanus indicus*). Dutt, Patel, and Soutakay (1943), however, show that it can cause some economic losses in cotton in India. Further, Pearson (1952) states that *H. armigera* is not a very serious pest of cotton in Africa. These observations may throw some light upon the disappointing results so far obtained in attempts to increase cotton yields in Queensland by applying insecticides to control *Heliothis.* In the United States, on the contrary, insecticidal control of the bollworm has consistently resulted in increased yields.

In coastal Queensland, as in coastal New South Wales, the major pest of tomatoes is probably *H. armigera.* This species has also been reared from maize at Wellington Point, near Brisbane, and from cotton and tobacco in the Burdekin Valley.

It now seems clear that damage to economic crops in Australia previously ascribed to *H. armigera* involves at least two species. Attacks on tomatoes, linseed, lucerne, canning and field peas, cabbages, deciduous fruits, and tobacco, in southern and Western Australia, in the Northern Territory, and in the inland areas of New South Wales and Queensland, are probably solely due to *H. punctigera.* In coastal New South Wales and coastal Queensland, as well as the Callide Valley, the most important pest is probably *H. armigera,* although *H. punctigera* occurs in part of this area (Fig. 1). The more important crops attacked are maize, tomatoes, cotton, lucerne, tobacco, and vegetables such as cabbages and beans. *H. rubrescens* (Walker), which also occurs commonly over most of Australia, has not been recognized as a pest, and its native host plant is not known. *Heliothis assulta* Guen., which is the major pest of tobacco in Sumatra (Van der Laan 1940), has not so far been recognized as a pest of this crop in Queensland. The Cape gooseberry, *Physalis peruviana* L., is also recorded as a host by Hampson (1903). It is possible, however, that it is also involved in attacks on tobacco in north Queensland, for Smith (1952) includes a photograph of this species in his account of Queensland tobacco pests, apparently believing it to be *H. armigera.*

The range of economic hosts attacked by *H. armigera* and *H. punctigera* overlaps markedly, but there is considerable circumstantial evidence that the former is not normally responsible for attacks on linseed in Australia, nor is the latter of much account in cotton. Specimens of *H. armigera* reared from linseed in New Zealand, however, have been examined by the author. Again, whereas *H. armigera* causes serious losses throughout the warmer months each year, *H. punctigera* appears to be usually most important in the spring and exhibits a marked periodicity in its attacks. Infestations occur in most years in a wide variety of crops, but extensive destruction is apparently caused only in occasional years.

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Explanation of Plate 1

Fig. 1.—Male of *Heliothis armigera* (Hübn.), upper side, from Burdekin Valley, Queensland, 11.i.1953, A. V. Hill and D. Wark (ex tobacco) (C.S.I.R.O.).

Fig. 2.—Female of *H. armigera* (Hübn.), upper side, from Home Hill, Queensland, 18.xi.1948, W. A. Smith (ex cotton) (Qd. Dep. Agric.).

Fig. 3.—Male of *H. armigera* (Hübn.), under side, from Brisbane, Queensland, 22.i.1903 (C.S.I.R.O.).

Fig. 4.—Female of *H. assulta* Guen., under side, from Brisbane, Queensland, April 1942 (C.S.I.R.O.).

Fig. 5.—Male of *H. assulta* Guen., upper side, from Eungella, Queensland, 9.x.1928 (C.S.I.R.O.).

Fig. 6.—Female of *H. assulta* Guen., upper side, from Brisbane, Queensland, 10.iv.1928 (C.S.I.R.O.).

Fig. 7.—Male of *H. punctigera* Wallengr., upper side, from Canberra, A.C.T., 9.ii.1953, I. F. B. Common (reared on *Calendula* ex eggs from ♀♀ in light trap) (C.S.I.R.O.).

Fig. 8.—Female of *H. punctigera* Wallengr., upper side, from Canberra, A.C.T., 9.ii.1953, I. F. B. Common (reared on *Calendula* ex eggs from ♀♀ in light trap) (C.S.I.R.O.).

Fig. 9.—Male of *H. punctigera* Wallengr., type, upper side, from "Sidney, New Holland" (Stockholm Museum).

Fig. 10.—Male of *H. punctigera* Wallengr., under side, from Canberra, A.C.T., 6.ii.1953, I. F. B. Common (reared on *Calendula* ex eggs from ♀♀ in light trap) (C.S.I.R.O.).

Fig. 11.—Male of *H. rubrescens* (Walk.), upper side, from Brisbane, Queensland, 7.vii.1942 (C.S.I.R.O.).

Fig. 12.—Female of *H. rubrescens* (Walk.), upper side, from Canberra, A.C.T., 26.xi.1952, I. F. B. Common (C.S.I.R.O.).

Fig. 13.—Female of pink form of *H. rubrescens* (Walk.), upper side, from Canberra, A.C.T., 29.x.1951, I. F. B. Common (C.S.I.R.O.).

Fig. 14.—Male of *H. rubrescens* (Walk.), under side, from Sydney, N.S.W. (C.S.I.R.O.).

OBSERVATIONS ON THE SENSORY PHYSIOLOGY AND BEHAVIOUR OF LARVAE OF THE CATTLE TICK, *BOOPHILUS MICROPLUS* (CAN.) (IXODIDAE)

By P. R. Wilkinson[*]

[*Manuscript received June* 24, 1953]

Summary

In larval cattle ticks the main sense organs which have been recognized are the eyes, Haller's organs, and the palpal organs; the four pairs of sensilla sagittiformia may also have a sensory function.

Larvae were allowed to ascend supports simulating grass stalks and were tested for response to vibration, air currents, interrupted illumination, warm and moist objects, and odours from skin secretions of man and cattle. The strongest questing response was to the odours. Larvae which had been exposed to low humidities collected around and imbibed from drops of water.

The main stimulus governing ascent of the grass blades appeared to be positive phototaxis to moderate light intensities. Larvae sheltered from direct sunlight. Larvae in the field were found to be more exposed in the early morning, often being at the tops of grass stalks. Measurements of light, air temperature, and humidity indicated that light intensity might govern this movement. This suggests that larval sampling in the pasture should take place in the first half of the morning.

In a single series of observations, larvae which had hatched at the base of straws were observed to ascend them in the late afternoon. In a few experiments isolated larvae ascended artificial supports above the reach of a bovine host but groups were always found at heights within reach.

I. Introduction

The observations described were made primarily to assist in developing a field sampling method for larvae of *Boophilus microplus* (Can.). The observations on the diel cycle of activity (Allee *et al.* 1949) were carried out to obtain information on the best time of day to sample.

II. Sense Organs of the Larvae

The sense organs of larvae, before and after hardening of the cuticle, were examined at magnifications from 60X to 980X. Polyvinyl alcohol mountants were principally used.

(*a*) *The Forelegs*

Haller's organ.—This organ is situated on the dorsal surface of the tarsus of each foreleg and is similar in structure to that figured by Lees (1948) for adult *Ixodes ricinus* L. Each organ consists of an anterior pit and a posterior capsule, each bearing a number of hairs.

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Schulze (1941) also studied Haller's organ in various stages of development of numerous species of ticks, including a female *Uroboophilus caudatus* (Neum.). In *B. microplus* larvae the number of thin-walled hairs in the posterior capsule is fewer than in *I. ricinus*, three long and one or two short hairs usually being discernible. Lees (1948) demonstrated that these hairs were chemoreceptors. The 'anterior pit' in *B. microplus* larvae is represented by a small promontory bearing two to four short stout hairs which taper sharply to a fine point. These short hairs are reported to be humidity receptors.

(*b*) *The Palps*

Palpal organ.—This is situated on the ventral surface of the tip of each palp and consists of a group of sensilla, inset in some species on a small area of cuticle. In *B. microplus* larvae it differs somewhat from that of *I. ricinus* adults, the last palpal segment being an eversible flap on which four short hairs *c.* 0.01 mm long, two hairs of intermediate length, and two long hairs *c.* 0.02 mm in length are mounted. The hairs of the rest of the palp have minute serrations whereas these are plain. The palpal organs are chemoreceptors and are thought to be concerned with the final stimuli causing attachment after the animal host has been reached (Lees 1948).

(*c*) *Sense Organs Elsewhere on the Body*

(i) *Eyes.*—Krijgsman (1937) was in error in describing the larvae of *Boophilus annulatus* (Say) (believed by the present author to be *B. microplus*) as eyeless.

The eyes appear laterally as transparent ovals on the posterior edge of the scutum. Minute striations are visible on the surface, these being finer than the folds in the epicuticle of the 'alloscutum' (= opisthosoma of some authors).

(ii) *Sensilla Sagittiformia.*—Four pairs of pit-like organs are conspicuous in whole mounts. One pair occurs behind each pair of legs. The first pair opens laterally, the next two pairs ventrally, and the last pair dorsally near the posterior margin of the opisthosoma. Dinnik and Zumpt (1949) described their regular and characteristic arrangement in various species of ixodid larvae, including *Boophilus calcaratus* Bir.

As pointed out by Dinnik and Zumpt (1949), these pit-like organs have frequently been described as 'stigmata' or 'spiracles' without any evidence of a respiratory function. For example, Lahille (1905), working with *B. microplus*, listed them as respiratory organs followed by a query. Before the work of Dinnik and Zumpt (1949) came to notice, an examination of the organs suggested that they had a sensory or glandular function as no tracheae were attached.

Dinnik and Zumpt (1949) homologized these organs with the sensilla sagittiformia described by Schulze (1942*a*) in adult ticks. From their morphology, Schulze had ascribed a glandular and sensory function to the organs and stated that they were probably vibro-chemoreceptors and that the secretion of the gland cells served both as a protective coating against evaporation from the sensillum, and as a chemical means of recognition both between opposite sexes and between individuals of the same species. He described a central 'tuft-like' structure between the lips of the organ. Douglas (1943) described sensory pits of unknown function in *Dermacentor andersoni* Stiles, which were generally distributed on the dorsal surface of the body. These pits superficially resemble the pit-like organs described above in *B. microplus* larvae, the resemblance being most marked in the anterior pair, in which the tuft is barrel-shaped. Each pit has a nerve cell and is therefore presumably sensory, although Neumann (1942) and Lees (1947) provisionally regarded them as dermal glands.

In an attempt to obtain more information on the structure of the sensilla sagittiformia of *B. microplus*, serial sections were cut of larvae fixed in alcoholic Bouin and stained either in Mallory's acid fuchsin stain or by Bodian's protargol method. The inner lips as described by Schulze were easily seen; in some sections two small strongly fuchsinophilic nuclei, possibly of nerve cells, were visible at the base of the organ, contrasting with the larger nuclei of the hypodermal cells. Some sections showed a 'tuft' or scolopale-like structure but no innervation was observed. Neumann (1942) figured one basal cell but no scolopale 'tuft' in *Haemaphysalis punctata* (Can. & Fanz.).

It seems unlikely that these comparatively large* and complex organs are purely glandular, but it has not been possible to prove a sensory function experimentally. From their structure, the organs may perhaps be associated with the perception of vibration or cuticle tension (cf. insect chordotonal organs, Wigglesworth 1939). In larvae the glandular secretion may permit recognition, leading to the clump-forming response observed in nature (Plate 1, Fig. 1). This recognition of a secretion would be similar to the supposed function of the dorsal foveae (Schulze 1942*b*) or porose areas (Lahille 1905) in the mutual stimulation of the male and female before mating. However, Schulze also suggested that the sensilla of the larval foveae might be the functionless precursors of adult organs. It may be relevant to note here that adult males of *Boophilus* are capable of recognizing females which are still in the nymphal stage, and attach themselves beneath them in readiness for their emergence.

(iii) *Sensilla Hastiformia and Sensilla Auriformia.*—Numerous organs of the type which Schulze (1942*a*) described as sensilla hastiformia and auriformia occur on the surface of the body. Neither type is as complex in structure as the organs mentioned above. Lees (1947, 1948) considered that the sensilla hastiformia might be purely glandular in *Ixodes* though Schulze ascribed a sensory function to them. Lees pointed out that certain malformed ducts resembled the sensilla auriformia of Schulze.

III. APPEARANCE OF LARVAL GROUPS IN THE FIELD

Larvae were observed in the field and in artificial infestations on grass plants growing naturally and in containers. Artificial infestations were produced by inserting eggs in plastic gauze containers or in small specimen tubes at the base of plants. For a variable period individual larvae wandered over the grass blades. On single grass blades, as used in later experiments, the larvae sometimes settled down in tight clusters near the top within an hour. On larger grass plants this might take up to 3 days.

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* Anterior pair 0.017 mm in diameter at base.

The number of larvae in a cluster and the number of clusters formed from one egg mass were varied. Thus when one egg mass of about 2000 eggs was placed at the base of each of three similar natural spear grass (*Heteropogon contortus* (L.) Beauv. ex Roem & Schultz) tussocks, eight, eight, and nine clumps were seen on each tussock 15 days later (eggs which remained in the incubator at 30°C and R.H. > 95 per cent. hatched 12 days earlier). One of the larger larval clumps removed to the laboratory numbered 70 larvae, and another large group (apparently two confluent groups from its shape) numbered 261 larvae. In one heavy natural infestation near a depression in the grass where a cow had been lying there were 19 groups ranging from 20 to *c.* 2000 individuals.

The larvae might still be present and active when the groups were no longer visible. Thus on the three grass plants mentioned above, the larval clusters were no longer visible 27 days later, but on crossing two of the tussocks five and seven larvae respectively were picked up on the 'trouser sampler' (Wilkinson, unpublished data).

IV. Ascent of the Grass Plant

The question arises whether larvae ascend the grass plant because of a positive phototaxis or a negative geotaxis.

Krijgsman (1937) found in laboratory experiments with *B. annulatus* (believed by the present author to be *B. microplus*) that larvae introduced into tubes gradually became more photopositive for 4 days after emergence and were finally attracted to even 'very bright diffuse daylight.' Krijgsman provided the larvae with illumination through 'a milk-glass window,' which may have given a light intensity of not much more than 2000 ft-candles. Although he found larvae photopositive under these conditions, in the field the larvae are found on the shady side of grass blades during the hours of strong illumination. At noon direct and indirect illumination in central Queensland may total over 10,000 ft-candles.

Using the milk-glass window to provide uniform illumination, Krijgsman found that, irrespective of the orientation of the T-tube, larvae distributed themselves uniformly over the two arms. He concluded that unfed larvae did not react to gravity. Lees (1948) concluded that *Ixodes* adults and nymphs showed a negative phototaxis combined with a form of negative geotaxis, whereas Jones (1950), working with the larvae of *Trombicula autumnalis,* concluded that if a negative geotactic response did exist it was weaker than the photopositive response.

A few simple experiments were tried with *B. microplus* larvae to decide whether light or gravity influenced their ascent of the plant.

About 2000 larvae were kept for 37 days in an atmosphere of 90 per cent. R.H. and then confined in a 2 by 1 in. tube covered with opaque black paper except for a strip 12 mm high by 5 mm wide at the bottom edge of the tube. (Room temperature was 98°F and relative humidity *c.* 28 per cent.) Two hr after the experiment commenced, one-third of the larvae were concentrated near the unshaded portion. In this experiment light appeared to be the dominant factor. This was supported by the fact that in a darkened incubator larval groups were not always formed at the top of the tube.

In another experiment larvae were on two occasions allowed to ascend a single grass stalk mounted on a cork. They formed the usual group at the top. Opaque paper cones were lowered over the tips to shade the top centimetre or so of the stalk. The larvae did not descend, although kept under observation until next day. However, when larvae were allowed to ascend a vertical arm of an open T-tube which was similarly shaded they did not form a group at the top but wandered about between the horizontal arm and the edge of the shaded portion. When the cone was removed larvae grouped at the top. Larvae also failed to group at the top of already shaded grass stalks. These last results seemed to confirm the conclusion that light is the principal factor causing the ascent of the larvae. It appears moreover that the tendency to remain in a group, once formed, is stronger than the stimulus of the light, which on the shaded supports would come from below.

V. Responses to Contact Stimuli, Shading, Vibration, Humidity, Warm Objects, Odours, and Air Currrents

(*a*) *Methods*

Since the principal aim of the study of larval reactions was to obtain information to assist in developing sampling methods, use was made of the questing response of larvae which had been allowed to ascend supports simulating those found in nature. Particularly in the testing of odours this was found to be more sensitive than placing the source of the odour in the centre of a flat surface, e.g. a glass plate, and observing the tracks of the larvae liberated at the edge, a method tried on mite larvae with inconclusive results by Jones (1950). However, Lees (1948) used both methods with success on *Ixodes* nymphs. It is possible with *Boophilus* larvae that some type of 'reaction chain' exists, as described by Tinbergen (1951), and that they respond to the stimuli only after they have taken the necessary preliminary step in nature of ascending the stalk.

In the earlier experiments on responses, larvae were allowed to ascend the stalks of a cut-down grass plant mounted in a 250-ml beaker. Later a single grass stalk inserted in the cork of a 2 by 1 in. tube was used except in the second series of odour tests, where the larvae ascended wire (dia. 1 mm). In all experiments a cylindrical celluloid screen had to be provided, as larvae otherwise detected the presence of the observer after a short time and commenced questing. In the celluloid screen a hole was cut about 1 in. square and a retort stand arranged so that a test-tube could be slid in to within ¼ in. of the top of the support. Larvae were liberated in the support and allowed to settle down for at least 24 hr. The 2 by 1 in. tube stood in a petri dish containing water, which prevented the escape of stray larvae and kept up the humidity. Larvae were first tested by some stimulus to which they usually responded strongly, to ensure that they were in a normal reactive condition. Adequate time was allowed for the larvae to settle down between each stimulus. Although the tests were only qualitative and most of the stimuli could not be defined quantitatively, tests were repeated and gave consistent results.

It proved quite simple to grade larval responses into three arbitrary divisions:

Strong response.—The larvae quested actively and much movement took place toward the source of the stimulus or the top of the support, often causing 'balling' of the larvae. More than three-quarters of the larvae were involved.

Medium response.—The larvae quested but did not move about. More than one-third of the larvae were involved.

Weak response.—Only a few of the larvae extended their forelegs.

It was noticeable both in the field and under artificial conditions that not all members of a group responded to a stimulus.

(*b*) *Contact Stimuli*

Larvae were liberated on grass blades and observed from down-wind while the trouser sampler of another observer contacted the group. It was found that larvae could transfer themselves to the trouser in the very brief time of contact even when they appeared quiescent before (cf. Lees 1948, p. 203). However, the whole group was never picked up. Thus three successive contacts on one group of 40 larvae picked up 34, 1, and 1 respectively. From another group of 30 the figures were 7, 3, and 15 respectively.

(*c*) *Vibration*

Larval response to vibration was investigated, the vibration being provided by a sharp blow on the table supporting the apparatus. Response on three separate days was classified as 'medium.' It is doubtful whether 'vibration of the soil and of plants caused by the approach' (Krijgsman 1937) is very important in the field. In the field observations mentioned above, the observer walking quite near the larvae disturbed them very little if no contact was made. The ground did not vibrate perceptibly and little movement of the grass blades was produced. In any case there may be a good deal of movement due to wind which would tend to swamp other movements.

(*d*) *Air Currents*

Air currents were provided by means of a bulb connected to a piece of glass tubing directed at the group under observation. A puff of air from this apparatus sufficient to cause just perceptible movement of the grass produced no response in a cluster of larvae. A violent puff of air producing a strong movement of the grass induced a weak response. When, however, they were blown upon through the tube with the breadth of the observer (i.e. olfactory and humidity stimuli added) there was a strong questing response. Winds being a rather frequently occurring feature of the larval environment in the Rockhampton district, one would not expect a strong response to air currents which did not carry olfactory, temperature, or humidity stimuli.

(*e*) *Shadows*

Jones (1950) noted a strong questing reaction when mites were temporarily shaded. Responses of *Boophilus microplus* larvae were 'weak' to the following illuminations, when interrupted: direct sunlight, strong diffused light from a window, and a 12-V 36-W focused microscope lamp.

(*f*) *Warm Objects*

No response was observed when a test-tube at room temperature (75°F) was placed close to larvae, but a test-tube at between 100.5 and 104°F (approximating bovine body temperature of 101.4°F) aroused a slight response, and when a finger of the observer was inserted into the apparatus, thus introducing combined temperature and odour stimuli, a strong response was observed.

(*g*) *Odours*

Examples of responses to odours have been given in Sections V (*d*) and V (*f*) above. In a further test at a room temperature of 93°F larvae did not respond to a clean test-tube, but quested strongly when the tube was reinserted in the apparatus after rubbing in human sweat. A tube to which was attached cow hair gathered 1½ hr previously produced a weak and a nil response respectively in two trials. The same group again reacted strongly when the tube rubbed in human sweat was reintroduced, but no response followed further tests with a clean tube at 105°F and a moist tube at room temperature.

A second series of experiments was carried out at a room temperature of 71°F with larvae released on wire 3 days earlier. A cotton wool swab (*A*) was rubbed on the flank and escutcheon of a cow, and another (*B*) in the mucus and saliva of the mouth and nostrils. Glass tubes were used as holders for the swabs during presentation to the larval clusters. Tests were started within ½ hr of the preparation of the swabs. The results of the observations on the larvae are presented in Table 1.

It will be seen that the strongest responses were to objects with an olfactory component. This agrees with the findings of Totze (1933) with adult *Ixodes*. The cow hair presumably had little odour compared with the swab which had been rubbed on the animal. It is probable that breath odours of cattle grazing would cause larvae in the neighbourhood to quest. Graybill (1911) noted that *B. annulatus* larvae quested on the approach of an observer and attributed this to an olfactory sense.

(*h*) *Free Moisture*

Although the tube moistened with water did not cause any response, suggesting that the effect of the tube rubbed with sweat was due to odour rather than humidity perception, larvae responded to moisture in another way. The response was strongest in larvae which had been exposed to a humidity at which they lost water, that is, they were slightly desiccated. During observations of larvae throughout the diel it was noticed that they were frequently covered with dew, and it was therefore of interest to determine whether they could ingest free water. It was observed that larvae would collect around a drop of water placed on the outside of a gauze tube cover (Plate 1, Fig. 2). Although larvae dropped on a water surface usually become motionless rapidly, the aggregation around a drop of water was quick enough to suggest a movement along a humidity gradient (taxis) rather than a random contact with and subsequent immobilization by the drop (kinesis). Looking through the drop it could be seen that some larvae had inserted their hypostomes. That they were imbibing was demonstrated by the uptake into the abdominal caeca of water containing methylene blue and neutral red.

TABLE 1

RESPONSES OF A CLUSTER OF *BOOPHILUS MICROPLUS* LARVAE TO SUCCESSIVE TEST MATERIALS

Test Material	Response
Glass tube which has been rubbed with swab *A* (dry, no mucus or saliva)	Weak
Swab *A*	Strong
Clean glass tube	Nil
Glass tube which has been rubbed with swab *B* (mucus and saliva)	Strong
Cotton wool moistened with alcohol or acetone extracts of swab *A* and allowed to dry	Nil
Swab *A*	Strong
Cotton wool impregnated with dimethyl phthalate	Nil; one larva walked down wire
Clean glass tube	Nil
Swab *A*	Strong

VI. BEHAVIOUR OF THE LARVAE IN THE FIELD THROUGH THE DIEL

Larvae observed during hours of bright sunshine were in concealed places, including seed heads of common grasses (*Heteropogon contortus*, *Sporobolus elongatus* R.Br., *Chloris gayana* Kunth) as well as beneath grass blades and in leaf axils. They were also found completely concealed in a grass blade which had become rolled up into a cylindrical form in dry weather. This was later found unrolled after rain, when the larvae were again visible.

Larvae on naturally growing grass plants were observed at intervals throughout a 24-hr period on a number of occasions. Grass stalks bearing suitable larval clusters were first labelled and later approached up-wind for observation. At the same time as the larvae were observed, readings were taken of light intensity,* temperature, and relative humidity (the last with a whirling psychrometer at a height of *c.* 3 ft). A conspicuous feature of the observations was the movement, usually at dusk or before dawn, of the larval groups into more exposed positions, often terminal, on the grass stalks. This occurred with most, but not all, of the clusters observed and the displacement was usually most obvious at dawn. Larvae were not observed repeatedly at night since the use of a light might upset their normal behaviour. Larvae often clustered at the top of a grass blade bent in an inverted U-shape. Under these circumstances they did not move to a terminal position but sometimes became more exposed by moving to the upper surface. Even when no upward movement of the group along the support was seen, it was noticed that, at dawn, larvae did not move back under cover as quickly after disturbance as they did when exposed to the midday sun. As noted above, larval groups were sometimes covered with dew. A number of species of grasses in the Rockhampton area give off a copious exudate from green leaves during the night; for example, the exudate from the tips of *Paspalum dilatatum* leaves was conspicuous even in drought time. Its occurrence may be a feature of importance in the biology of *B. microplus* larvae.

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* A Weston photoelectric exposure meter graduated in candles/ft^2 was held over an unglazed porcelain tile (reflectance taken as 80 per cent.). As the reading exceeded the scale at midday, a stop was inserted behind the high-scale screen so that only one-sixth of the area was exposed, resulting in readings at midday between 400 and 600. These readings were converted to ft-candles according to the methods of Shirley (1945) and "The S.E.I. exposure meter" (Ilford: London). In early work khaki webbing was used as the reflecting surface and no stop was fitted. This was found to give about the same reading as the tile with the stop fitted to the meter.

Observations on larvae made in August may be quoted as an example of winter behaviour. Observations were made at 12 noon, 2 p.m., 4 p.m., 6 p.m., 6.30 a.m., 8.10 a.m., 10 a.m., and 12 noon on naturally occurring larvae near an old night 'lair' of cattle. Three groups were observed, one 3 in. from the tip of a thin stalk, one under the bend of a U-shaped blade, and one distributed among notches near the top of another blade. No movement of larval clusters was observed until 6 p.m. Then it was noticed that the larvae had moved out of shelter, one group having moved 3 in. to the end of their stalk. The light intensity was less than 18 ft-candles compared with 10,000 ft-candles at noon, but the humidity was still low at 23 per cent. R.H. At 6.30 a.m. the next morning the light intensity was greater than 37.5 ft-candles, the humidity 66 per cent. R.H., and the temperature 48°F. All larvae were well exposed and 16 other neighbouring groups were terminal and well exposed, although all had been concealed the day before. By 8.10 a.m. some of the larvae had moved down again, the light intensity being 4700 ft-candles, relative humidity 28 per cent., and temperature 64.5°F. At 10 a.m. the light intensity was 9400 ft-candles, relative humidity 15 per cent., and temperature 72°F, and the migration back into cover was complete except for five larvae out of one cluster of 100. This movement was completed by noon, when the light intensity was 9400 ft-candles and the relative humidity 17 per cent.

The following observations made in February are cited as an example of the summer behaviour of naturally occurring larvae. Two out of five larval groups were terminal on their grass stalks at 5.45 a.m., when the air was still, the temperature 68°F, relative humidity 90 per cent., and light intensity 75 ft-candles. Another group was in its position of maximum exposure at 5.55 p.m. (82°F, 69 per cent. R.H., 1070 ft-candles, Bft.* 1) and the two remaining groups were most exposed at 7.0 p.m. (76°F, 80 per cent. R.H., light intensity 0, Bft. 0). Maximum concealment of all groups was at 12.35 p.m. and 1.20 p.m. (89-95°F, 48-50 per cent. R.H., 14,000 ft-candles, Bft. 1-3). The distances moved by larval groups varied from 0.5 to 3.0 cm. There was some evidence that the movement was delayed in overcast weather.

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* Wind velocity on the Beaufort scale.

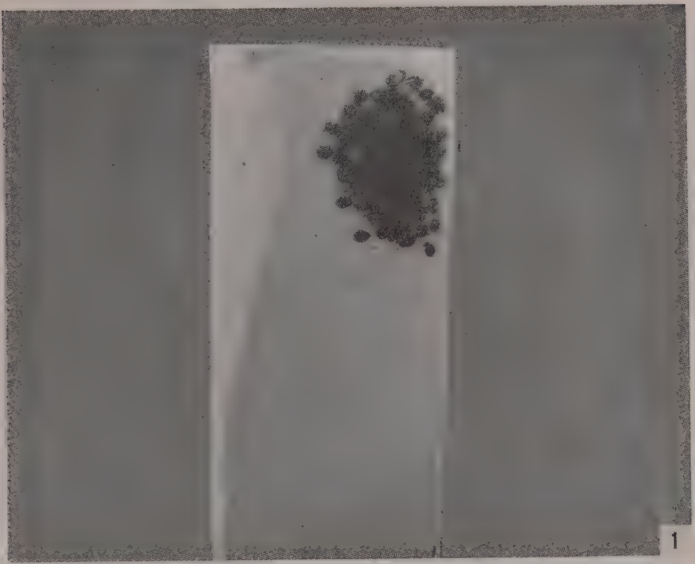
Rees (1950) described an interesting parallel to this daily migration in the behaviour of the infective larvae of the nematode *Haemonchus contortus* (Rudolphi). This author found that temperature, humidity, and light intensity were the main factors in vertical migration. Usually the greatest numbers of larvae were on the grass blades in the early morning and in the evening, fewer being recovered at night and during the middle of the day; the time of the morning maximum became progressively earlier passing from winter to summer and the time of the evening maximum progressively later, the reverse being true in the second half of the year.

In Rockhampton in rainless weather the daily march of relative humidity follows the familiar regular curve in antiphase to the temperature curve but it is not known whether it is the higher humidity or the lower light intensity that causes cattle tick larvae to leave sheltered positions. The winter figures for 6 p.m. quoted above suggest that it may be a response to lowered light intensity since the humidity was still low. The movement may be advantageous to the larvae since much cattle grazing, movement, and 'play' (e.g. running and fighting of young bullocks) takes place at dawn and dusk and the larvae are also in a position to contact the frequent dews. In sheltered positions they avoid the heating effects of the sun, which would increase their water loss, and they are to some extent sheltered from air movements. In the Rockhampton district there is usually little breeze at dawn and dusk, but winds during the early afternoon are a fairly regular feature.

Because of the tendency of the cattle tick larvae to seek concealment when solar radiation is intense, sampling for the measurement of larval populations should be commenced before 9 a.m. in summer. Many observations at different times of the year indicated that larvae were exposed in the early morning. On the other hand, a preliminary study of the pick-up of larvae from groups on a trouser sampler indicated that there was a minimum pick-up at midday.

According to Milne (1950) nymphs and adults of *Ixodes ricinus* become activated when beginning to dry out and come to rest in the humid 'mat' at the base of the vegetation. When their body water is replenished they are available for return to the grass tips. In Queensland there is frequently no 'mat' of decaying vegetation at the bases of the plants in the environment of larval *Boophilus microplus*, and no behaviour of this species corresponding with that described in *Ixodes ricinus* has been recorded, either in the above or in other observations. It seems probable that, once the larvae of *B. microplus* have ascended after hatching, they perform movements only over very short distances as described, in response to diurnal fluctuations in meteorological conditions.

The ascent of larvae after hatching was observed only once. Eggs were placed at the base of vertical drinking straws sunk 2 in. into soil in flower pots. The larvae ascended four of the straws, and formed groups of 20-100, between 3.0 and 4.30 p.m. The temperature during this period fell from 92 to 86°F and the relative humidity rose from 38 to 44 per cent.



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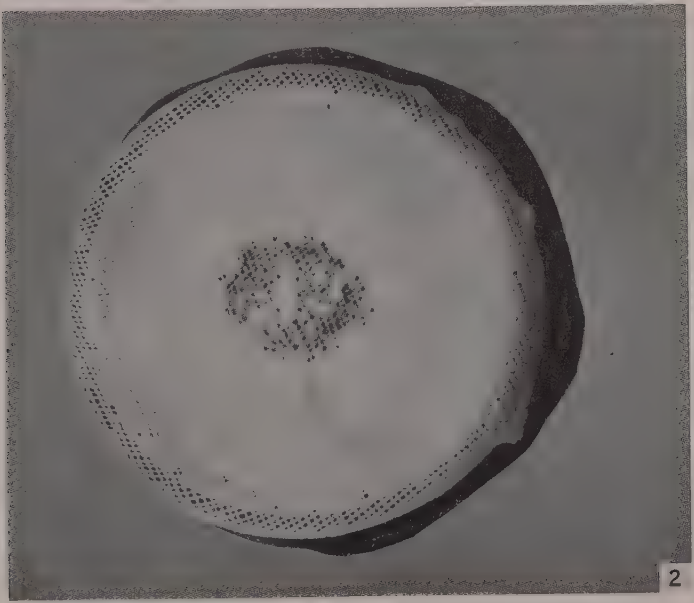

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Fig. 1.—Larvae in group at top of artificial support (drinking straw).
Fig. 2.—Larvae grouping round water droplet.

VII. HEIGHT OF ASCENT OF LARVAE

Grasses such as Nepal grass which occur in the environment of the larval cattle tick attain a height of 6 ft, and weeds such as Noogoora burr, flannel weed, and thistles may reach heights of over 4 ft. Saplings, 'scrubs,' and timber regrowth also occur in the tick habitat, so that in connection with the design of sampling apparatus it is of interest to know to what height larvae ascend.

Larvae 1 month old were liberated 4 ft 3 in. above ground on a wooden lath reaching 9 ft 5 in. from the ground. Next morning the topmost larva was 8 ft 2 in., but no grouping was seen. Five days later one larva was at the top and another was at 9 ft 3 in. Another batch of 5-day-old larvae was liberated at 3 ft 6 in. on the same lath after removal of the others. Two days later one larva was at 9 ft 3 in. and there was a cluster of about 13 at 4 ft. In these experiments larvae were liberated above ground to avoid the brace of the lath. In a later experiment larvae were liberated from a tube 3 in. above the base of an unbraced vertical lath projecting 10 ft from the ground surface. Next day one larva was at 67 in. and another at 68 in. but the majority were in groups at 21, 25, 29, 30, 33, 39, and 48 in. from the ground. Five days later the largest group was at 30 in. The highest group was at 48 in., and other groups were at 45, 42, 40, 28, 26, 22, 19½, 18, and 14½ in. At all the group heights mentioned larvae could encounter bovine hosts.

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THE AUSTRALIAN PSYCHODIDAE (DIPTERA), PART I

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Summary

A new genus of Psychodidae, *Atrichobrunettia*, gen. nov., is erected to contain species showing affinities with *Brunettia* Annandale, but lacking hairs on the wing membrane. Two new species are described, *A. alternata*, sp. nov., and *A. subalternata*, sp. nov. Three new subgenera of the genus *Telmatoscopus* Eaton are created; *Paratelmatoscopus*, subgen. nov., containing 2 new species, *Telmatoscopus* (*P.*) *variegatus*, sp. nov., and *T.* (*P.*) *subvariegatus*, sp. nov.; *Nototelmatoscopus*, subgen. nov., containing the species *T.* (*N.*) *festivus*, sp. nov., *T.* (*N.*) *crassepalpis*, sp. nov., *T.* (*N.*) *obscurus*, sp. nov., and *T.* (*N.*) *nicholsoni*, sp. nov.; *Eutelmatoscopus*, subgen. nov., containing the species *T.* (*E.*) *neglectus*, sp. nov., *T.* (*E.*) *norrisi*, sp. nov., *T.* (*E.*) *confusus*, sp. nov., and *T.* (*E.*) *fordi*, sp. nov., all of which species are described, as also is *T. poncianicolus*, sp. nov., a species of uncertain subgeneric affinity. Two new species are described of the hitherto monotypic genus *Notiocharis* Eaton, *N. dimorpha*, sp. nov., and *N. pallida*, sp. nov. A new species of the monotypic

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genus *Trichopsychoda* Tonnoir, *T. montana*, sp. nov., is described, as also are 2 species of *Pericoma* Walker, *P. confusa*, sp. nov., and *P. pseudoalbipes*, sp. nov., and 11 species of *Psychoda* Latreille, *P. dennesi*, sp. nov., *P. aenigmatica*, sp. nov., *P. unimaculata*, sp. nov., *P. irrorata*, sp. nov., *P. truncata*, sp. nov., *P. subpennata*, sp. nov., *P. squamata*, sp. nov., *P. arcuata*, sp. nov., *P. squamipleuris*, sp. nov., *P. apennata*, sp. nov., *P. ypsylon*, sp. nov.

Further descriptions are given of the species *Pericoma bancrofti* Tonnoir and *Psychoda pseudoalternata* Williams.

The name *Psychoda infurcis* Satchell is shown to be a synonym of *Psychoda makati* Del Rosario.

Keys to the genera and species of Australian Psychodidae, including those described in Part II, are provided.

INTRODUCTION

André Léon Tonnoir died at Canberra on January 30, 1940, whilst on a collecting trip. His untimely death deprived Australia of a distinguished economic and general entomologist, and the world of its undisputed authority on the family Psychodidae. On leaving Belgium in 1921 Tonnoir collected Psychodidae in Australia for 2 years before proceeding to New Zealand in 1924. He returned to Australia in 1929, rejoining Dr. R. J. Tillyard at Canberra as Senior Ecologist and Curator at the Division of Economic Entomology. Here he stayed until his death. It is noticeable that during his 14 years residence in Australia he published little on the Australian Psychodidae although he wrote largely on the Psychodidae of other parts of the world. A study of his manuscript notes shows that from 1921 to 1923, and from 1929 up to the time of his death he was collecting material and writing notes on what was clearly intended to be a monographic treatment of the Australian members of this family.

On his death the bulk of the collection and the manuscript notes were acquired by the School of Public Health and Tropical Medicine, Sydney, a small proportion of the collection being retained by the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.). Through the great kindness of Professor E. Ford of the Sydney School of Tropical Medicine, and Dr. A. J. Nicholson, of the C.S.I.R.O., I have been loaned these collections and manuscript notes, in the hope that some of the material could be published. The notes contain species descriptions in all stages of completion. Tonnoir had a standard procedure in describing a species. Firstly he drew pencil sketches and wrote a description of the species on small sheets of writing paper measuring 5½ by 8¼ in. Sometimes the same structure would be drawn a number of times, the separate sheets being pinned together into a bundle. The notes were then typewritten and a selection of the drawings traced on to bristol board. The typewritten account was then extensively altered and corrected in small handwriting between the lines, and up and down the sides of the sheet. Finally the corrected copy was retyped and the pencil drawings inked in. The description of only one species had reached this stage of completion; that of *Pericoma illustrata*, sp. nov. Several others have reached the stage of handwritten corrections on the first typewritten copy. The majority are in the stage of handwritten notes. I have adopted the convention that all accounts that have reached the first typewritten stage should be published as they stand, under Tonnoir's name, providing that they contain no apparent error. These descriptions have been collected together as Part II of this paper. Species in which the description was less advanced have been redescribed completely. This has also given me the opportunity to incorporate much new material collected in January 1940, immediately prior to his death. As with the New Zealand species, however, I must acknowledge the great debt I owe to Tonnoir in that his manuscript descriptions in many cases made my task easier.

In listing the specimens in the collection I have recorded the name of the collector only when they were collected by someone other than Tonnoir. In order to save space I have not included the State after a place name, these being listed under States in Appendix I at the end of Part II. Tonnoir's collections were made almost entirely in Tasmania, Victoria, New South Wales, and the Australian Capital Territory. A number of specimens were sent him by Mr. K. R. Norris from Western Australia, and there are a few Queensland specimens. There are no specimens from Northern Territory or Central or South Australia. It is almost certain that many more species await to be collected.

The keys to genera and species are included in Part I. That to the genus *Pericoma* is based in part on one designed by Tonnoir in his manuscript notes, though I have had to expand it to include another two species present in the 1940 material. I have not felt impelled to describe every species included by Tonnoir in his manuscript descriptions, as not all of the original collection is now present in the cabinet. I am reluctant, for example, to erect a new species of *Psychoda* on the strength of a single ♀, unless there is something quite remarkable about it. I have retained Tonnoir's suggested species names except where they were invalid, or have become so by subsequent descriptions.

The only published descriptions of specifically Australian Psychodidae are those of *Nemopalpus australis* Alexander 1928, *Pericoma townsvillensis* Taylor 1915, *Pericoma bancrofti* Tonnoir 1920, and three species of *Phlebotomus* (*P. queenslandi* Hill 1923, *P. brevifilis* and *P. englishi* Tonnoir 1935).* In addition, the New Zealand species *Psychoda spatulata*, *P. harrisi*, and *P. penicillata* (Satchell 1950*a*), the Pacific Island species *P. makati* Del Rosario 1936, and *P. pseudoalternata* Williams 1943, and the cosmopolitan *P. alternata* Say, *P. cinerea* Banks, and *P. severini* Tonn. subsp. *parthenogenetica* Tonn. are known to occur there. In the Tonnoir collection are specimens of some 50 new species, of which 42 are described in this paper. Practically all the well-known temperate and tropical genera occur in Australia, *Nemopalpus* Alexander, *Phlebotomus* Rondani, *Sycorax* Haliday, *Trichomyia* Haliday, *Pericoma* Walker, *Notiocharis* Eaton, *Telmatoscopus* Eaton, *Brunettia* Annandale, *Psychoda* Latreille, and *Trichopsychoda* Tonnoir being represented. In addition, a new genus, *Atrichobrunettia*, gen. nov., will be described in this paper. Australia has thus as varied and abundant a psychodid fauna as any zoogeographical region in the world as far as our present knowledge of the distribution of this family goes.

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* Since this was written a paper by Dr. G. B. Fairchild has appeared (Proc. Linn. Soc. N.S.W. 77: 189 (1952)), describing additional new species of *Phlebotomus* from Australia. These are *P. brevifiloides*, *P. pexopharynx*, and *P. buccinator*.

Tonnoir mentions in his notes that Psychodidae are commonly taken in Australia by sweeping the herbage bordering streams and other damp places. They should be taken home alive, killed with ammonia fumes, and pinned on fine points immediately. Details of the vestiture such as the distribution of erect and decumbent hairs on the wing veins are important as diagnostic features, and are rapidly destroyed if the specimens are allowed to die and rattle about in their tubes. The majority of species can only be identified with certainty from a microscopic examination of the genitalia and antenna; these should be removed, prepared in the usual way, and mounted in balsam on a strip of coverslip under the specimen.

Description of Species

Key to Australian Genera of the Family Psychodidae

1. Flagellar segments of antenna fusiform without a definite neck................2
Flagellar segments with a swollen basal bulb and a narrow apical neck........7
2 (1). *Rs* 3-branched i.e. only 1 vein intervening between the 2 forks..............3
Rs 4-branched, i.e. 2 veins intervening between the 2 forks..................4
3 (2). *Cu* long, reaching at least to level of medial fork............*Trichomyia* Haliday
Cu short, scarcely reaching to level of origin of *Rs*..............*Sycorax* Haliday
4 (2). *Cu* more than ½ as long as M_4......................................5
Cu short, less than ½ as long as M_4, sometimes almost absent................6
5 (4). Antenna 12-segmented in ♂, 15-segmented in ♀............*Notiocharis* Eaton
Antenna 16-segmented in both sexes...................... *Pericoma* Walker
6 (4). Radial sector pectinate, mouth-parts modified for blood sucking..............
Phlebotomus Rondani (3 spp., key in Tonnoir 1935)[*]
Radial sector dichotomous, mouth-parts normal......... *Nemopalpus* Macquart[†]
7 (1). Last 1-3 antennal segments diminutive and lacking necks................... 8
Terminal segments not diminutive; all flagellar segments with necks........... 9
8 (7). Hairs on the wing veins but not on the wing membrane.... *Psychoda* Latreille
Hairs on both veins and membrane ....*Trichopsychoda* Tonnoir
9 (7). Antennae 16-segmented in both sexes; ♂ with retinaculae not racket-shaped......
Telmatoscopus Eaton
Antennae 15-segmented in both sexes; ♂ with racket-shaped retinaculae........10
10 (9). Hairs on the veins but not on the wing membrane......*Atrichobrunettia*, gen. nov.
Hairs or scales on the under surface of the wing membrane as well as on the veins..
Brunettia Annandale

Key to Australian Species of the Family Psychodidae

Genus Notiocharis Eaton

Blackish brown species ....*N. dimorphus*, sp. nov.
Whitish species...... ....*N. pallida*, sp. nov.

Genus Psychoda Latreille

1. Wing forks incomplete.............................*P. makati* Del Rosario
Wing forks complete..2
2 (1). Antennae apparently 14- or 15-segmented..............................3
Antennae 16-segmented.. 6

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[*] Now 6 species. See Fairchild, G. B. (1952).—Proc. Linn. Soc. N.S.W. 77: 189. A key to all 6 species is presented in this paper.

[†] One described sp., see Alexander 1928.

3 (2). Antennae 14-segmented.......... *P. severini* Tonn. subsp. *parthenogenetica* Tonn.
Antennae 15-segmented..........4
4 (3). 14th segment of antenna very small and naked, separated from 13th; a dark transverse zigzag fascia across the wing.......... *P. spatulata* Sat.
14th segment of antenna not naked, partially fused with 13th; dark spots at the vein tips, ascoids reduced..........5
5 (4). ♂ with style sinuate in profile, ♀ with Y-shaped subgenital plate.......... *P. alternata* Say
♂ with style evenly tapered and curved in outline, ♀ with subgenital plate replaced by a tubular process.......... *P. pseudoalternata* Williams
6 (2). Last 3 antennal segments spherical, well separated..........7
Segments 14 and 15 spherical, with no trace of a neck between; sensory cones on 13 and 15.......... *P. harrisi* Sat.
7 (6). Sensory cones on antennal segments 13 and 15; cercopods long and evenly tapered, subgenital plate fish-tail-shaped.......... *P. dennesi*, sp. nov.
Segments 13-16 lacking sensory cones..........8
8 (7). Ascoids with only a single anterior branch..........9
Ascoids of the usual Y type..........11
9 (8). Wing without dark tufts on the disc.......... *P. aenigmatica*, sp. nov.
Wing with 1 or more dark tufts on the disc..........10
10 (9). Wing with a single dark tuft over the radial fork.......... *P. unimaculata*, sp. nov.
Wing with numerous dark tufts on the disc.......... *P. irrorata*, sp. nov.
11 (10). ♀ with a truncate subgenital plate as in Figure 11*D* and reduced ovipositor. ♂ unknown.......... *P. truncata*, sp. nov.
Not such species..........12
12 (11). Costal pad of ♂ wing extended to form a ventrally reflected flap, bearing a pencil of squamuliferous hairs, extending parallel with the ventral surface of the wing..13
Costal pad not so extended; costal tuft if present lying along costa..........15
13 (12). Tuft full, solid, curved; 9th sternite extended posteriorly at lateral margins; hairs on dorsum of abdomen replaced by scales.......... *P. penicillata* Sat.*
Tuft otherwise; 9th sternite not extended posteriorly; vestiture on dorsum of abdomen predominantly hairy..........14
14 (13). Costal tuft forming a narrow pencil of hairs under wing; abdominal vestiture completely hairy.......... *P. subpennata*, sp. nov.
Costal tuft forming a diffuse bunch of scales under wing; abdominal vestiture hairy dorsally, scaly laterally.......... *P. squamata*, sp. nov.
15 (13). Under surface of wing with hairs replaced by scales in basal third..........16
Under surface of wing with normal hairy covering; at most a few scattered scales interspersed..........17
16 (15). Lateral piece of aedeagus arcuate and widely separated from main piece.......... *P. arcuata*, sp. nov.
Lateral piece of aedeagus fitting closely under main piece.. *P. squamipleuris*, sp. nov.
17 (15). Aedeagus with main piece laterally extended to form a shelf-like flange; retinaculum ½ as long as cercopod.......... *P. apennata*, sp. nov.
Aedeagus with main piece stiffened by a thickened ridge running down its length..18
18 (17). Cercopods 1.4 times as long as 9th tergite, slightly swollen at base, tapering evenly to tip; styles subequal to coxite.......... *P. ypsylon*, sp. nov.
Cercopods almost equal to 9th tergite, broad in basal ½, tapering suddenly ¾ way along. Styles 1.5 times as long as coxite.......... *P. cinerea* Banks

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* The females of the species subsequent to and including *P. penicillata* cannot be distinguished with certainty.

Genus Pericoma Walker

1. Species with a uniformly dark or pale brown covering.... 2
Species with white or dark markings on the wing 3
2 (1). Origin of stem of radial fork after apex of 1st basal cell; length of this stem less than ¼ length of R_2; ascoids multibranched in ♂ .... *P. uniformata*, sp. nov. (Part II)
Origin of stem of radial fork before apex of 1st basal cell; length of this stem almost ½ of R_2; ascoids simple in both sexes ....*P. confusa*, sp. nov.
3 (1). Forks on same level.... 4
Radial fork placed distinctly before medial.... 6
4 (3). Black tufts round wing margin at vein tips, no white space in wing fringe.. .... *P. punctulata*, sp. nov. (Part II)
Wing fringe with white spaces in it.. 5
5 (4). Wing fringe white at apex and at 2 other places as well.. .... ***P. illustrata*, sp. nov. (Part II)**
Wing fringe white at apex only...... ......*P. subillustrata*, sp. nov. (Part II)
6 (3). Medial fork distinctly after level of tip of *Cu*; a pale brown species with no white in wing fringe, cercopods with a single retinaculum...... .. .. *P. tasmaniae*, sp. nov. (Part II)
Medial fork either immediately above or before level of tip of *Cu*........ 7
7 (6). Medial fork immediately above level of tip of *Cu* in ♂, very slightly more basalwards in ♀, fringe whitish at apex of wing, ♂ with numerous retinaculae along length of cercopod.. .. ..*P. bancrofti* Tonn.
Medial fork distinctly before level of tip of *Cu* in both sexes (a group of 4 species separable with certainty only in the ♂).... 8
8 (7). Wing veins completely or partially covered with scales on under surface of ♂ wing.... 10
Wing veins devoid of scales in ♂ 9
9 (8). Styles of ♂ straight...... ....***P. albipes*, sp. nov. (Part II)**
Styles of ♂ sinuate........ .. ..*P. pseudoalbipes*, sp. nov.
10 (8). Scales on under surface of wing broad and extending to wing tip; subgenital plate as in Part II, Figure 38*F*.... ....*P. rotundipennis*, sp. nov. (Part II)
Scales on under surface of ♂ wing narrow and confined to basal ½; subgenital plate as in Part II, Figure 39*I*.... ......*P. intricatoria*, sp. nov. (Part II)

Genus Telmatoscopus Eaton

1. Eyes extended above antennae to form bridges. Basal flagellar segment with some neck, though it may be shorter than bulb 3
Eye bridges absent, basal flagellar segment oval, quite without a neck (subgenus *Paratelmatoscopus*).. 2
2 (1). ♂ genitalia as in Figure 19*H*...... ....*T. variegatus*, sp. nov.
♂ genitalia as in Figure 20*D*.... ... .*T. subvariegatus*, sp. nov.
3 (1). R_4 at wing tip, forks with dark tufts, metatarsi dark, rest of tarsi white.. ..... . *T. townsvillensis* (Taylor) (Part II)
R_4 above wing tip.. 4
4 (3). Wing ovolanceolate, erect hairs absent on R_1....... 5
Wing broadly ovate; erect hairs present on R_1 (subgenus *Nototelmatoscopus*)....6
5 (4). With paired multibranched ascoids in the ♂; body hairs brownish, tipped with white in both sexes; radial fork before medial .. *T. poncianicolus*, sp. nov.
With paired single, curved ascoids in both sexes; radial fork after or above medial (subgenus *Eutelmatoscopus*) 11
6 (4). Legs with tarsi showing a pale, creamy, or even white reflection in certain lights, contrasting with the fuscous tibiae; a group of 5 species with very characteristic and easily distinguished ♂♂, but almost identical ♀♀ 7

Legs uniformly fuscous 10

7 (6). ♂ with median anterior region of pronotum bearing an area of short, dark scales, flanked by long, erect tufts 8

Median anterior region of pronotum not so modified or if slightly scaly, not flanked with long, erect tufts 9

8 (7). ♂ * wing much flattened on anterior margin . . . . *T. festivus*, sp. nov.

♂ * wing normal . . . . *T. gregsoni*, sp. nov. (Part II)

9 (7). ♂ † with palps much thickened and scaly . . . . *T. crassepalpis*, sp. nov.

♂ † wing with *Rs* 3-branched, apparently 1 fork in the disc . . . . *T. dimorphus*, sp. nov. (Part II)

♂ † with under surface of wing scaly in basal 4/5 . . . . . . *T. obscurus*, sp. nov.

10 (6). Wing with radial fork very slightly before or immediately above medial . . . . *T. viduatus*, sp. nov. (Part II)

Radial fork distinctly before medial . . . . *T. nicholsoni*, sp. nov.

11 (5). Pale ochraceous species with no pattern on the wing, long, very much curled ascoids in the ♂ and completely separate squarish lobes on the subgenital plate of the ♀ . . . . *T. neglectus*, sp. nov.

Not such species 12

12 (11). Pale ochraceous species with dark transverse fasciae across the wing and white rings at apices of tibiae and 1st tarsal joints . . . . *T. norrisi*, sp. nov.

Mainly fuscous species with no dark transverse fasciae and unicolorous legs 13

13 (12). ♂ with base of R_3 switched to R_4 so only 1 vein intervenes between forks. ♀ with R_3 and M_2 prolonged backwards as a twig beyond fork . . . . *T. aberrans*, sp. nov. (Part II)

Both sexes with normal venation 14

14 (13). ♂ with a single retinaculum on cercopod; ♀ with characteristic subgenital plate and spermathecae . . . . *T. confusus*, sp. nov.

♂ with 4 or more retinaculae on cercopod 15

15 (14). ♂ with large, scoop-shaped aedeagus; ♀ with lobes of subgenital plate widely separated . . . . *T. spiralifer*, sp. nov. (Part II)

♀ with subgenital plate not divided by median indentation. ♂ unknown . . . . *T. fordi*, sp. nov.

Genus ATRICHOBRUNETTIA, gen. nov.

Species with ♂ and ♀ genitalia as in Figure 30*E*, *H* . . . . . . *A. alternata*, sp. nov.

Species with ♂ and ♀ genitalia as in Figure 31*D*, *H* . . . . *A. subalternata*, sp. nov.

Genus SYCORAX Haliday

Sycorax Haliday, 1839, in Curtis, Brit. Ent. **16**: 745.

In some manuscript notes of Tonnoir's on a projected paper revising the genus *Sycorax* is a description of an Australian species of this genus. The specimens are not in the collection, so no description can be given, but the genus does apparently occur in Australia.

Genus TRICHOMYIA Haliday

Trichomyia Haliday, 1839, in Curtis, *Brit. Ent.* **16**: 745.

A single female specimen of a new species of *Trichomyia* occurs in the Division of Entomology Museum, C.S.I.R.O., Canberra, but I am reluctant to erect a new species on such inadequate material, and am leaving it undescribed. The genus does, however, undoubtedly occur in Australia.

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* The ♀ of *T. festivus* and *T. gregsoni* are indistinguishable.

† The females of these three species are very alike and can be distinguished only by minor differences in the subgenital plates.

Genus NOTIOCHARIS Eaton

Notiocharis Eaton, 1912-13, Trans. Linn. Soc. (2) **15**: 427.

In the collection are numerous specimens labelled by Tonnoir *Parapericoma dimorpha,* and fewer specimens of a 2nd species, *Parapericoma pallida.* Types and paratypes have been selected and notes written on the species, but there is no account of the proposed new genus. In 1913 Eaton erected a genus *Notiocharis* to contain a single species, *N. insignis* from the Seychelles, and a comparison of Eaton's figures of the male antenna, wing, and cercopods with these structures in Tonnoir's 2 species, indicates that they belong to this genus. The genus is peculiar in having the antenna 12-segmented in the male and 15-segmented in the female, in having the male styles bifurcated, in lacking eye bridges, and in having a markedly pectinate radial sector. These are the first 2 species to be added to the genus since Eaton's description of the type species.

NOTIOCHARIS DIMORPHA, sp. nov.

Fig. 1

A small fuscous species with 2 dark spots on the wing disc.

Male

Mouth-parts and clypeus with a covering of brown decumbent scales, frons with a covering of erect squamuliferous hairs. Eye bridges vestigial (Fig. 1*A*). Antenna 12-segmented, 1.3 times wing width, scape and pedicel with a brown scaly covering, flagellum greyish with widely open verticils; scape almost 3 times (Fig. 1*B*) as long as wide, pedicel distinctly (1.4 times) longer than wide, basal flagellar segment the longest, 3.5 times as long as wide, with its greatest width a little below the middle; subsequent segments shorter and more fusiform; terminal segment (Fig. 1*C*) with a tapering apiculus almost as long as the segment. Ascoids simple short rods, in pairs on segments 4-11 (Fig. 1*D*). Palpi (Fig. 1*E*) long, 0.6 length of antennae, covered with brown scales, palpal formula 1 : 1.6 : 1.6 : 2.

Thorax with an erect fuscous vestiture of long hairs with some scales intermixed on the anterior margin; a tuft of squamuliferous hairs in front of, and another behind, the wing base. Allurement organ present on membrane in front of mesonotum above head, consisting of an exsertile vesicle covered by a seta-bearing plate; vesicle (Fig. 1*F*) evenly and minutely setulose.

Wing very lanceolate (Fig. 1*G*), 2 mm long, apex between R_4 and R_5; radial fork above or slightly before medial; *Rs* pectinate, distance from base of *Rs* to origin of R_{2+3} 0.6 of length of stem of R_{2+3}; 1st basal cell longer than 2nd, both cells extending well into wing; base of *Rs*, M_{1+2}, and M_4 continued well beyond base of R_5 and M_3; *Cu* short, straight, and thickened basally. Vestiture fuscous with darker brown decumbent tufts at veins tips; dark brown tufts of erect hairs at ends of R_2 and M_3, placed just behind decumbent tufts, forming

2 small dark spots on wing disc; erect hairs absent on R_1, R_3, R_5, and on M_1 and M_2 beyond fork; present almost to tip of R_2 and M_3, along whole length of stem of medial fork, and on basal ½ of R_4; wing fringe fuscous with a white space at tip of rather variable extent, extending from R_4 to M_1; under surface of wing with hairs replaced by scales for a varying extent on basal quarter of R_1, Rs, and M_{1+2}. Legs with fuscous covering, the tarsi white in certain lights.

Abdomen with a covering of decumbent squamuliferous hairs dorsally, and of normal erect hairs laterally. Hypopygium (Fig. 1*H*); coxite broad with an internal process, style bifurcated and shaped as in Figure 1*H*; internal process of style with a slightly curved tip, bearing 6 or so setae subterminally; aedeagus symmetrical, broad, with a central stiffening rod bifurcated at the tip; cercopods (Fig. 1*I*) cylindrical, evenly tapered, not swollen basally, very slightly longer than 9th tergite, with 6 simple retinaculae; anal flap of complex shape as shown in Figure 1*I*.

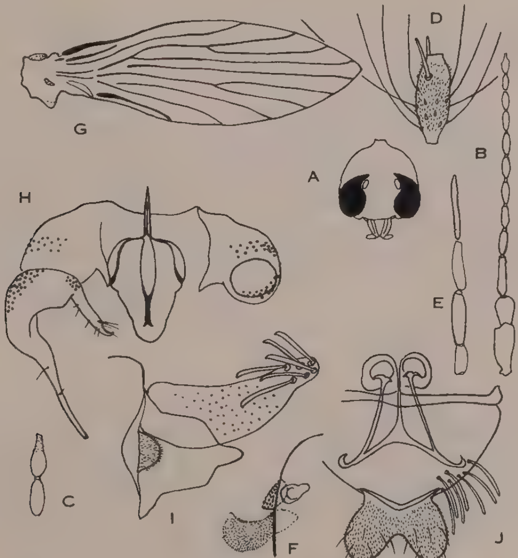

Fig. 1.—*Notiocharis dimorpha*, sp. nov. *A*, head; *B*, antenna; *C*, antennal tip; *D*, flagellar joint; *E*, palp; *F*, allurement organ; *G*, venation; *H*, hypopygium; *I*, cercopod; *J*, subgenital plate.

Female

Similar to male except that the antenna is 15-segmented and the basal flagellar segment is not so long. Subgenital plate fish-tail-shaped as in Figure 1*J*, spermathecae without reticulate thickenings on capsules, ovipositor twice as long as subgenital plate.

Type: Eaglehawk Neck, 20.xi.1922.

Allotype: Geeveston, 8.xii.1922.

Paratypes: 8♂, 1 ♀, with type, 1 ♀ with allotype, 9 ♂, 8 ♀, Burnie, 7.x.1922. 1♂, 2♀, Narooma, Jan. 1940. 2 ♂, 1 ♀, Shannon Creek, 13.xi.1938. 2 ♂, Tilba Tilba, 8.i.1940. 1 ♂, Fitzroy Falls, 22-27.xi.1937. 1 ♀, Blundells, 7.i.1930.

Other specimens: 3 ♂, 3 ♀, Narooma, Jan. 1940. 1 ♂, 1 ♀, Tilba Tilba, 8.i.1940. 10 ♂, 4 ♀, Shannon Creek, 20.xi.1939, 13.xi.1938. 3 ♂, 4 ♀, Blundells, 4.iii.1930. 1 ♂, 1 ♀, Narara, 8.xi.1921. 1 ♂, Eurobodalla, 7.i.1940. 2 ♀, Fitzroy Falls, 22-27.xi.1937. 1 ♀, Lee Spring, 20.xii.1930. 1 ♀, Stanwell Park, 29.xii.1938. 1 ♂, National Park, N.S.W., 6.xii.1922. 1 ♀, Burnie, 27.x.1922.

Six paratypes and 3 other specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

NOTIOCHARIS PALLIDA, sp. nov.

Fig. 2

A small whitish species with 2 brown spots on the wing disc, and a brown mark at the wing tip.

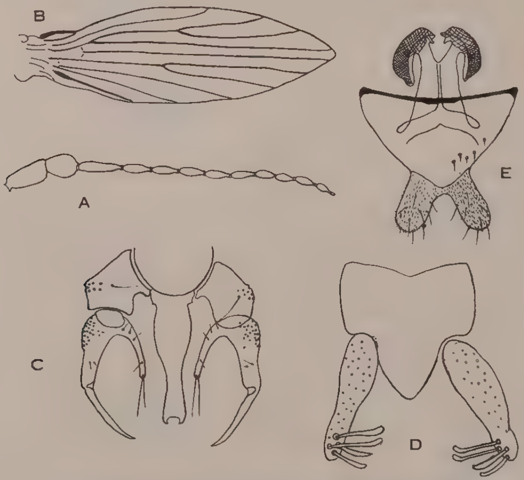

Fig. 2.—*Notiocharis pallida*, sp. nov. *A*, antenna; *B*, venation; *C*, hypopygium; *D*, cercopods; *E*, subgenital plate.

Male

Mouth-parts and clypeus with a covering of whitish decumbent scales, frons with a covering of erect whitish squamuliferous hairs. Eye bridges vestigial. Antenna 12-segmented (Fig. 2*A*), 1.2 times as long as wing width, flagellum white with widely open verticils; scape with a covering of white squamuliferous hairs, 3 times as long as wide, pedicel distinctly longer than wide, basal flagellar segment the longest, 3.5 times as long as wide with its greatest width below middle; subsequent segments shorter and more fusiform; terminal segment with apiculus almost as long as segment; ascoids (as far as can be ascertained from the rather excessively cleared specimens available) as in *N. dimorpha.* Palpi long, 0.7 length of antenna, covered with whitish scales, palpal formula 1 : 1.8 : 1.7 : 2.6.

Thorax with a vestiture of erect whitish hairs with scales intermixed on anterior margin; some rather indistinct scale tufts on pleura below wings; allurement organ not visible in specimens available. Wings (Fig. 2*B*) 1.8 mm long, apex between R_4 and R_5, radial fork distinctly after medial; distance from base of *Rs* to origin of R_{2+3} 0.4 length of stem of R_{2+3}; 1st basal cell longer than 2nd; *Cu* short and straight, thickened basally. Vestiture pale ochraceous to whitish; dark brown decumbent tufts at tips of R_4, R_5, M_1, and M_2; a weaker tuft at tip of M_4; erect brown tufts on M_3 at level of tip of M_4 and on R_2 just beyond fork; erect hairs distributed as in previous species; wing fringe unicolorous apart from an indistinct infuscation extending from R_5 to M_3 and visible only in certain lights. Under surface of wing with scaling on same veins as in previous species, but less extensive, scarcely extending beyond apex of 1st basal cell.

Abdomen with a covering of whitish decumbent squamuliferous hairs dorsally, and of normal erect hairs laterally. Hypopygium (Fig. 2*C*); coxite angulated externally, with a very small internal process near the base; style bifurcated with internal process not hooked apically, shaped as in Figure 2*C*, and terminating in 2 long setae; external process (style proper) bent through an angle of 60° half way along its length; distal portion gently tapering and finely pointed; aedeagus narrow, elongate, hour-glass-shaped; cercopods (Fig. 2*D*) cylindrical, not swollen basally, 1.4 times as long as 9th tergite, bearing 4 simple retinaculae; anal flap triangular.

Female

Similar to male except that the antenna is 15-segmented and the basal flagellar segment is shorter; subgenital plate (Fig 2*E*) with longer and less rounded lobes than *N. dimorpha*; spermathecae as in Figure 2*E*, with strongly reticulate capsules. Ovipositor long, 2.2 times as long as subgenital plate.

Type, allotype, and 5 ♂, 4 ♀ paratypes: Narara, 3.xi.1921.

Genus PERICOMA Walker

***Pericoma* Walker, 1856, Ins. Brit. Dipt. 3: 256.**

PERICOMA CONFUSA, sp. nov.

Fig. 3

A uniformly ochraceous species with a single broad retinaculum on each cercopod.

Male

Head with decumbent clypeal and erect facial tuft. Eye bridges separated by less than width of ½ a facet. Antenna 16-segmented, 1.4 times as long as width of wing, scape and pedicel with scaly covering, verticils closed; scape

1.8 times as long as broad (Fig. 3*A*) basal flagellar segments fusiform, terminal ones oval (Fig. 3*B*), the apical one with an apiculus longer than the basal bulb; ascoids paired, simple curved rods on segments 3-15. Palpal formula 1 : 1.6 : 2.4 : 3.3.

Thorax with a long ochraceous hairy vestiture; no allurement organ present. Wing (Fig. 3*C*) 2.1 mm long; wing apex just above tip of R_5; *Sc* joined to R_1, prolonged as a fold parallel with R_1, radial fork before medial, both near wing base and well before tip of *Cu*; origin of R_{2+3} a little before apex of 1st basal cell, which is longer than 2nd. Wing covering and fringe uniformly ochraceous, erect hairs absent on R_1, R_5, and M_4, continued to just short of vein tips on remainder. Legs ochraceous.

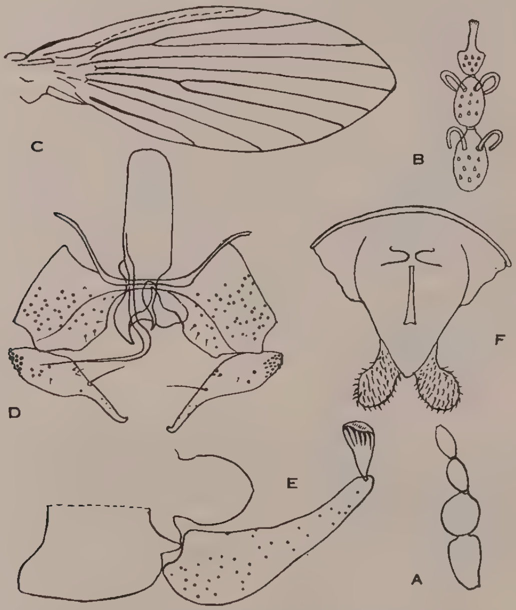

Fig. 3.—*Pericoma confusa*, sp. nov. *A*, base; *B*, tip of antenna; *C*, venation; *D*, hypopygium; *E*, cercopod; *F*, subgenital plate.

Abdomen with long ochraceous hair. Hypopygium (Fig. 3*D*) with 9th sternite a little thicker than usual; coxites broader than long, extended medially at base to meet in mid line, forming a bridge behind 9th sternite; style 1.4 times as long as coxite, swollen basally, tapering rather abruptly to a curved pointed tip; aedeagus consisting of (*a*) a median piece which bends through a right angle and extends laterally as a thread-like pointed flagellum; (*b*) a flattened, laterally placed, hook-like piece; and (*c*) on the other side, a small laterally placed hook-like piece. Cercopods (Fig. 3*E*) ½ as long again as 9th tergite, swollen basally, and tapering gradually to end in a single rather broadly flattened retinaculum; anal flap as in Figure 3*E*.

Female

Similar to male, subgenital plate with well-separated lobes (Fig. 3*F*), ovipositor 1.8 times as long as subgenital plate.

Type, 4 ♂, 2 ♀ paratypes: Wentworth Falls, 18.xi.1921.

Allotype, 1 ♂ paratype: Fitzroy Falls, 22-27.xi.1937.

Paratypes: 4 ♂, 1 ♀, Kangaroo Valley, 11.ii.1933. 1 ♂, Stanwell Park, 29.xii.1938. 1 ♂, 2 ♀, Macquarie Pass, 23.xii.1934.

Other specimens: 1 ♂, Macquarie Pass, 23.xii.1934. 1 ♀, Wentworth Falls, 18.xi.1921. 1 ♀, Kangaroo Valley, 11.ii.1933.

As Tonnoir's allotype was a little damaged I have selected another from his paratypes. Three paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

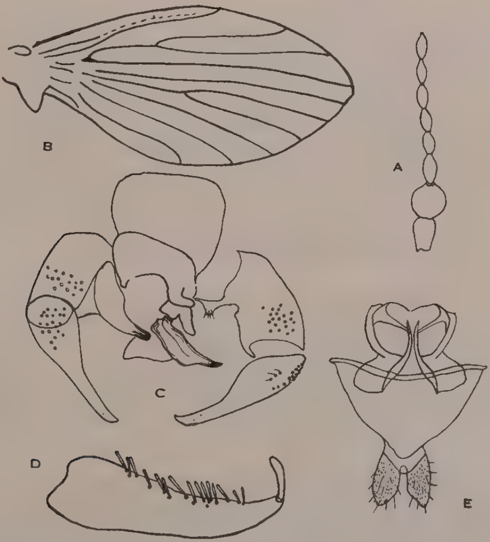

Fig. 4.—*Pericoma bancrofti* Tonnoir. *A*, antenna base; *B*, venation; *C*, hypopygium; *D*, cercopod; *E*, subgenital plate.

PERICOMA BANCROFTI Tonnoir

Fig. 4

Pericoma bancrofti Tonnoir, 1920, Ann. Soc. Ent. Belg. **66**: 153.

In his original description Tonnoir drew the male genitalia incorrectly.

The presence of further specimens in the collection, and some brief notes, indicates that he intended redescribing it in his paper.

A rufous-brown species with white tarsi and darker spots at the vein tips.

Male

Decumbent tuft on clypeus, erect tuft on face. Eye bridges 4 facets wide, touching in the mid line; fringe of fuscous scales overhanging eyes. Antennae 16-segmented, slightly less than wing width; scape (Fig. 4*A*) 1.5 times as long as wide, flagellar segments barrel-shaped, terminal apiculus as long as bulb. Palpi fuscous, scaly, palpal formula 1 : 1.4 : 1.5 : 1.7.

Thorax with a rufous hairy covering, no allurement organ present. Wing (Fig. 4*B*) 1.8 mm long, apex between R_4 and R_5; radial fork before medial fork, the latter at the level of the tip of *Cu*; origin of R_{2+3} before apex of 1st basal cell, which is equal to 2nd. Wing vestiture rufous with a darker brown erect tuft over medial fork and darker decumbent tufts at vein tips; wing fringe bronzy with a paler space, whitish in certain lights, around the apex; erect hairs absent on R_1, R_5, and M_4, present on other veins to level of a line joining tip of R_1 to tip of M_4; under surface of wing not scaly. Legs brown, tarsi entirely white.

Abdomen with a long hairy vestiture. Hypopygium (Fig. 4*C*); coxite longer than wide, style short and abruptly tapered; aedeagus consisting of a rectangular, heavily sclerotized element bearing a pointed tooth, and a semicircular element bearing a blunt tooth, both articulated to the main body of the aedeagus. Cercopods (Fig. 4*D*) a little longer than 9th tergite, cylindrical with a short terminal retinaculum and 25 or so short, bottle-brush-like retinaculae.

Female

Similar to male, subgenital plate as in Figure 4*E*. 2 ♂, 3 ♀, Narooma, 29.xi.1930.

PERICOMA PSEUDOALBIPES, sp. nov.

Fig. 5

Closely related to *Pericoma albipes* (Part II), but differing from it in the absence of a definite allurement organ and in the form of the male genitalia.

Male

Clypeus covered with reclined fuscous squamuliferous hairs; face bearing an erect tuft; eye bridges separated by a width less than ½ a facet; a fringe of fuscous scales on the vertex. Antenna 16-jointed, 0.8 of wing width, scape and pedicel with fuscous scaly covering; scape (Fig. 5*A*) 1.4 times as long as broad, flagellar segments fusiform, the terminal one (Fig. 5*B*) bearing an apiculus as long as the basal bulb; ascoids paired simple rods. Palpal formula 1 : 1.7 : 1.9 : 2.6.

Thorax with a fuscous hairy covering, lacking any tufts of scales; anepisternite lacking any definite display or allurement organ, but lower ½ of anepisternite (Fig. 5*C*) protuberant and bearing numerous small pores. Wing (Fig. 5*D*) 1.95 mm long, venation similar to that of *P. albipes*; radial fork before medial, both before level of tip of *Cu*; *Sc* joining R_1, prolonged as a fold; 1st basal cell a little longer than 2nd. Wing covering fuscous, without markings apart from an indistinct erect brown tuft over medial fork; erect hairs reaching to tip of R_2 and *Cu*, and almost to tip of other veins (apart from R_1, R_5, and M_4, which lack erect hairs). Wing fringe long and fuscous with a whitish space around wing apex of varying extent according to angle of light. Legs fuscous, tarsi white.

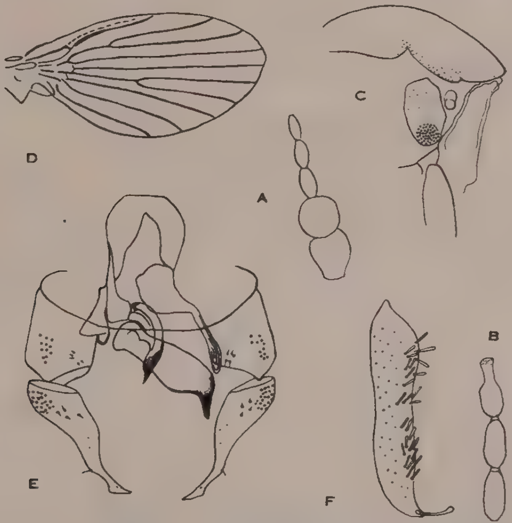

Fig. 5.—*Pericoma pseudoalbipes*, sp. nov. *A*, base; *B*, tip of antenna; *C*, anepisternite; *D*, wing; *E*, hypopygium; *F*, cercopod.

Abdomen with a long fuscous covering. Hypopygium (Fig. 5*E*); coxites a little longer than wide; styles longer than in *P. albipes*, sinuate, and terminating in a distinct heel-like portion. Aedeagus complex, consisting of 4 elements: (*a*) a large, rectangular, median piece bearing a sclerotized tooth; (*b*) a curved element also terminating in a sclerotized point, overlying (*a*) and articulating proximally with (*c*), a small, lateral element which extends anteriorly as one side of the broad, diffuse ejaculatory apodeme; (*d*) a lightly sclerotized, spoon-like element placed laterally on the other side of (*a*) and (*b*). Cercopods (Fig. 5*F*) elongate, 1.8 times as long as the 9th tergite, cylindrical, scarcely tapering, terminating in a single retinaculum of the usual form, and bearing numerous bottle-brush-like retinaculae on the dorsal and inner faces; anal flap simply triangular.

Type: Wyndham, south-eastern New South Wales (no date).

Paratypes: 7 ♂, Narooma, Jan. 1940. 1 ♂, Clyde Mt., 23.xi.1930.

The ♀ of this species is probably indistinguishable from that of *P. albipes*. Numerous specimens of *P. albipes* were collected by Tonnoir at Narooma during January 1940, and the ♂ specimens of *P. pseudoalbipes* were only found amongst them when the preparations of the genitalia were being mounted. It is likely that amongst the large number of ♀ ♀ collected at the same time, some of ♀ *pseudoalbipes* were taken. As I am unable to recognize any differences amongst the ♀ specimens in the cabinet, I am leaving them all under the *P. albipes* label, as Tonnoir originally placed them. Tonnoir had recognized the male as being a distinct species, but had not yet written any notes on it.

Genus PSYCHODA Latreille

Psychoda Latreille, 1796, Hist. Nat. Crus. et Ins., Precis. 152.14.293.

Psychoda makati Del Rosario

Fig. 17*H*

Psychoda makati Del Rosario, 1936, Philippine J. Sci. **59**: 568.
Psychoda infurcis Satchell, 1950, Proc. R. Ent. Soc. Lond. B **19**: 180-1.

In describing this species as a new one, from Fiji, I overlooked Del Rosario's description of it, from Luzon, Philippines. Tonnoir, in his manuscript notes has a description of it under the name of *Psychoda bancrofti.* His specimens are from Townsville and Eidsvold, Queensland, and through the kindness of Mr. R. F. Riek, I have recently seen numerous specimens amongst light-trap material from Yeerongpilly, Queensland. I have also collected the species in Samoa and Raratonga, and it is probably common throughout the Pacific islands in tropical latitudes.

In my description I gave an inaccurate figure of the tip of the antenna. I am taking the opportunity of correcting this (Fig. 17*H*). The species is probably related to *P. harrisi* Sat. as both show the partial fusion of antennal segments 13, 14, and 15 and the presence of paired hairy lobes at the sides of the subgenital plate.

Psychoda spatulata Satchell

Psychoda spatulata Satchell, 1950, Trans. R. Ent. Soc. Lond. **101**: 166.

There are several specimens of this New Zealand species in the collection from localities in Tasmania, Victoria, and A.C.T.

Psychoda pseudoalternata Williams

Fig. 6

Psychoda pseudoalternata Williams, 1943, Proc. Hawaii Ent. Soc. **11**: 336.
Psychoda pseudoalternata Williams, 1946, Proc. Hawaii Ent. Soc. **12**: 637.

In the collection are very numerous specimens of this species, mostly from Canberra, though one is from Yass, N.S.W. (collected Miss K. English), another from Wentworth Falls, N.S.W., and a third from Fremantle, W.A. Before Tonnoir's death he was sent some specimens of this, at that time undescribed, species by Dr. F. X. Williams of Honolulu. Tonnoir identified them and returned them to Williams who subsequently (1943) published a brief description of them, under the heading *Psychoda pseudoalternata* Tonn. Dr. Allan Stone drew Williams's attention to the status of the species, and at a later date (1946) Williams published a further description of it. I am redescribing it here, as Williams's accounts do not adequately distinguish it from *P. alternata* Say. *P. alternata* Say is probably the most widely spread of all species of Psychodidae, being reported from most of the countries of the world. In spite of its wide distribution and poor powers of flight, no closely related species had been reported prior to Williams's brief account of *P. pseudoalternata.* The tendency for species to be grouped in pairs or clusters of closely related forms, separable only by differences in the male genitalia, is very well developed in the Psychodidae, and it was surprising that no local variants of *P. alternata* had been described. *P. pseudoalternata,* although quite obviously related to *P. alternata,* is nevertheless distinguished by easily recognizable differences in the genitalia, whilst the female genitalia are not only quite different from those of *P. alternata* but are unlike those of any other described species of the genus. This is unusual in that the females of geminate species are usually indistinguishable.

A whitish yellow species with black dots at the ends of the wing veins obviously related to *P. alternata* Say, but possessing markedly different genitalia.

Male

Decumbent yellowish tuft on clypeus, erect tuft on face; antennae 15-segmented, 1.2 times as long as wing width, scape and pedicel with yellowish scaly covering, verticils open; scape (Fig. 6*A*) 1.2 times as long as wide, basal flagellar segment with neck only ½ as long as bulb, increasing in length in subsequent segments, reaching its greatest length in segment 10 where it is 4/5 of bulb length; segment 12 (Fig. 6*B*), with distinctly shorter neck; segments 13 and 14 so intimately fused that only a slight decrease in diameter 2/3 of distance along indicates presence of 2 segments; 15th segment small, distinctly separated; less than 1/3 diameter of 13th; ascoids 3-armed, stellate, on each of segments 3-13. Palpi yellowish, palpal formula 1 : 1 : 1 : 1.4 (Fig. 6*C*).

Thorax with whitish yellow vestiture. Wing (Fig. 6*D*) 1.1 mm long, radial fork a little after medial, both before tip of *Cu*; interfork distance 0.2 of distance from radial fork to apex of 1st basal cell, which is a little longer than 2nd; origin of R_{2+3} on R_4 very slightly after apex of 1st basal cell; wing veins and membrane slightly infuscated at vein tips; erect hairs present almost to tips of all veins except R_5, M_2, and M_4; hairs brownish black apart from white erect hairs on R_1, R_{2+3}, and R_4 just before radial fork, and just before tips of R_1, R_2, R_3, R_4, M_1, M_3, and *Cu*; brownish black tufts of adpressed hairs at tips of each vein; wing fringe unicolorous. Legs unicolorous.

Abdomen with a covering of whitish yellow hair. Hypopygium (Fig. 6*E*) with 9th sternite oval in outline; coxite longer than wide, style ½ as long again as coxite, slender, tapering, almost straight, but curved slightly downwards and inwards; lacking the usual lateral tuft of hairs, bearing numerous sensory setae scattered along its length; aedeagus simple, consisting of a median element with a reduced transverse element laid across it basally. Cercopod (Fig. 6*F*) elongate, curved inwards, only slightly swollen basally, almost 3 times as long as 9th tergite, bearing a single retinaculum 1/6 length of cercopod.

Female

Similar to male. Genitalia (Fig. 6*G*) unique in that subgenital plate is apparently missing, its place being taken by a large cylindrical tubular process into which open 2 pairs of sclerotized capsules probably of a glandular nature; this structure is normally partly hidden under a curtain of dense, long, squamuliferous hairs borne on the posterior margin of the last sternum; spermathecae as in Figure 6*H*, ovipositor of moderate length.

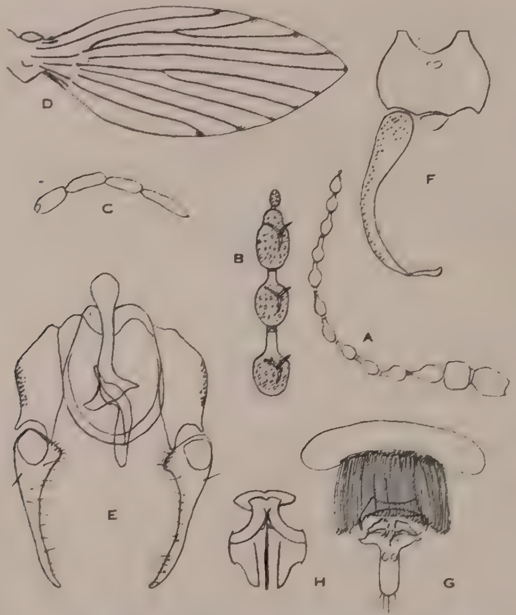

Fig. 6,—*Psychoda pseudoalternata* Williams. *A*, antenna; *B*, tip of antenna; *C*, palp; *D*, venation; *E*, hypopygium; *F*, cercopod (reduced by 0.73); *G*, ♀ genitalia; *H*, spermathecae.

Specimens: 21 ♂, 21 ♀, Canberra, Apr. 1939. 1 ♂, 1 ♀, Black Mt., 14.iv.1930. 1 ♂, Eastwood, Sept. 1923. 1 ♂, Nomans Lake, 8.vi.1938 (K. Norris). 2 ♂, Wentworth Falls, 18.xi.1921. 1 ♂, Ferntree Gully, 25.x.1921. 1 ♀, Katanning, 2.viii.1937 (K. Norris). 1 ♀, Killara, 29.x.1931. 1 ♀, Fremantle, 5.iii.1934 (K. Norris). 1 ♀, Yass, Mar. 1932 (K. English). 1 ♀, Dun Mt., New Zealand, 13.ii.?.

P. pseudoalternata is clearly widely distributed in Australia, being reported from Victoria, New South Wales, A.C.T., and Western Australia.

PSYCHODA HARRISI Satchell

Psychoda harrisi Satchell, 1950, Trans. R. Ent. Soc. Lond. **101**: 171-2.

This characteristic species was originally described from New Zealand. Numerous specimens of it are present in the collection from localities in Tasmania, Victoria, New South Wales, A.C.T., and Western Australia. It is obviously widely distributed in Australasia.

PSYCHODA DENNESI, sp. nov.

Fig. 7

A small, uniformly ochraceous species with characteristic genitalia.

Male

Sparse ochraceous tuft on face; eye bridges 4 facets wide, separated by width of 2 facets. Antennae 16-segmented, 1.7 times as long as width of wing, uniformly ochraceous with closed verticils; scape 1.3 times as long as broad (Fig. 7*A*); basal flagellar segment with neck shorter than bulb; longer than bulb in succeeding segments until it is 1.2 times as long as the bulb in segment 10; segments 14-16 (Fig. 7*B*) diminutive, well separated, subspherical, with sensory cones on 13 and 15; ascoids 3-branched. Palpi ochraceous, palpal formula 1 : 1.3 : 1.4 : 2 (Fig. 7*C*).

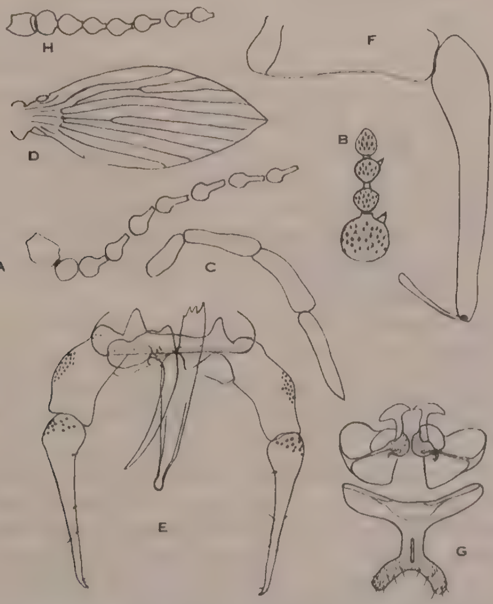

Fig. 7.—*Psychoda dennesi*, sp. nov. *A*, antenna of ♂; *B*, antenna tip of ♂; *C*, palp; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, subgenital plate and spermathecae; *H*, antenna of ♀.

Thorax with a uniformly ochraceous covering; wing (Fig. 7*D*) 1.3 mm long, radial fork after medial, both before tip of *Cu*; wing covering and legs uniformly ochraceous.

Abdomen with sparse ochraceous hair. Hypopygium (Fig. 7*E*) with 9th sternite straight and rounded at corners; coxites longer than wide, style very long and straight, with a few sensory setae; aedeagus with 1 straight piece ending in a slightly spatulate tip, and 1 curved pointed piece. Cercopods very long and thin, 1.5 times as long as 9th tergite, with a single short retinaculum (Fig. 7*F*).

Female

Antenna shorter, with the necks never equal to the bulbs (Fig. 7*H*); subgenital plate fish-tail-shape (Fig. 7*G*); spermathecae of characteristic shape, ovipositor 1.7 times as long as subgenital plate.

Type and allotype: Townsville, Queensland, June 1927. The specimens were collected by Mr. G. Dennes, after whom the species is named.

PSYCHODA AENIGMATICA, sp. nov.

Fig. 8

A uniformly ochraceous species with long antennae.

Male

Ochraceous tuft on face and between antennae. Eye bridges 4 facets wide meeting in mid line. Antennae 16-segmented, twice as long as width of wing, uniformly ochraceous, verticils closed; scape slightly (1.1) longer than wide (Fig. 8*A*), basal flagellar segment amphora-shaped, with neck equal to bulb, neck longer than bulb in succeeding segments, bulb slightly eccentric (Fig. 8*B*), terminal 3 segments only ½ diameter of 13th (Fig. 8*C*); ascoids (Fig. 8*B*) in pairs on segments 3-13, with a single twisted anterior arm much broadened at the base, and a long posterior arm. Palpi ochraceous, palpal formula (Fig. 8*D*) 1 : 1.6 : 1.9 : 2.1.

Thorax with ochraceous covering. Wing 1.9 mm long (Fig. 8*E*) with *Sc* thickened, radial fork after medial, both before tip of *Cu*, origin of R_{2+3} at apex of 1st basal cell, which is considerably longer than the 2nd. Wing vestiture uniformly ochraceous, lacking any darker markings; fringe unicolorous. Legs unicolorous.

Abdomen with long ochraceous hair. Hypopygium with 9th sternite curved upwards medially (Fig. 8*F*), coxites longer than wide, swollen distally but narrowing towards their insertion on the 9th tergite; style only slightly longer than coxite, straight in basal 2/3, then tapering rather suddenly to a curved point; scattered sensory setae near base, numerous minute sensory setae on inner face of curved region (Fig. 8*G*); aedeagus complex, consisting of (*a*) a tapering, pointed piece forming a continuation of the main body of the aedeagus; (*b*) a sickle-shaped piece with a short, blunt handle and a broad, curved blade articulated to the rest of the aedeagus; (*c*) a crescentic piece placed crosswise, bluntly spoon-shaped at one end and pointed at the other; and (*d*) a lightly sclerotized rod which is a process of (*b*); cercopods slightly longer than 9th tergite (Fig. 8*H*), tapering evenly, with a single retinaculum of great length, equal to almost ½ of cercopod.

Female

Similar to male but ascoids rather smaller; subgenital plate with median indentation feebly developed (Fig. 8*I*); spermathecae as in Figure 8*I*, with reticulate markings; ovipositor short, 1.5 times as long as subgenital plate.

Type, allotype, and 1 ♀ paratype: Hobart, 29.x.1933.

Paratypes: 1 ♂, Sassafras, 19.x.1922. 1 ♂, Ferntree, 19.xi.1922. 1 ♂, Mt. Wellington, 28.xi.1922. 2 ♂, 2 ♀, Weldboro Pass, 25.x.1933. 1 ♀, Eaglehawk Neck, 18.xi.1922. 1 ♀, Wentworth Falls, 18.xi.1922.

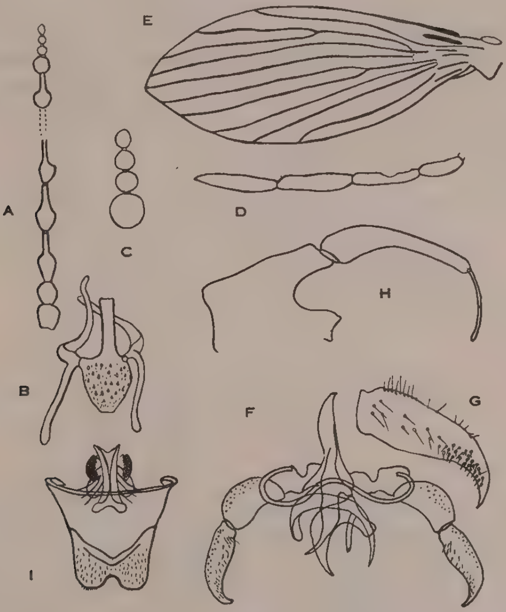

Fig. 8.—*Psychoda aenigmatica,* sp. nov. *A,* antenna; *B,* 5th antennal joint; *C,* antenna tip; *D,* palp; *E,* venation; *F,* hypopygium; *G,* style enlarged, seen from inner face; *H,* cercopod; *I,* subgenital plate and spermathecae.

Other specimens: 7 ♂, 5 ♀, Weldboro Pass, 25.x.1933. 8 ♂, 2 ♀ with type. 3 ♀, Fitzroy Falls, 3.x.1938. 2 ♂, 1 ♀, Burnie, 21-22.x.1923. 5 ♂, 3 ♀, Sassafras, 19.x.1922. 1 ♂, Eaglehawk Neck, 18.x.1922. 1 ♀, Mt. Farrel, 9.ii.1923. 1 ♀, Ferntree, 12.x.1922. 1 ♀, Waterfall, Nov. 1921. 1 ♀, Ferntree Gully, 25.x.1921. 1 ♀, Hobart, 23.x.1933. 1 ♀, Launceston, 15.x.1933. 1 ♀, Narara, 3.xi.1921. 1 ♀, St. Patrick's R., 31.x.1922. Sex undetermined, Kangaroo Valley, 11.ii.1933. 2 ♀, Bridgetown, 8.viii.1937.

Three ♀ specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

Tonnoir had provisionally named this species *Psychoda* (*Logima*) *deviata.* However, the species name *deviata* is already in use for one of his African species, very different to this, and he decided to drop the subgenus *Logima* in his "Synopsis of the British Psychodidae" (1940). I have therefore provided a new name.

Psychoda unimaculata, sp. nov.

Fig. 9

An ochraceous species with a single dark tuft over the radial fork.

Male

Ochraceous tuft on face and between antennae. Eye bridges 4 facets wide, meeting in the mid line. Antennae 16-segmented, twice as long as width of wing, uniformly ochraceous, verticils closed; scape (Fig. 9*A*) slightly (1.1) longer than wide, basal flagellar segment amphora-shaped, with neck equal to bulb, neck a little longer than bulb in succeeding segments, bulb slightly eccentric; terminal 3 segments spherical, only ½ diameter of 13th (Fig. 9*B*), ascoids as in previous species. Palpi not investigated.

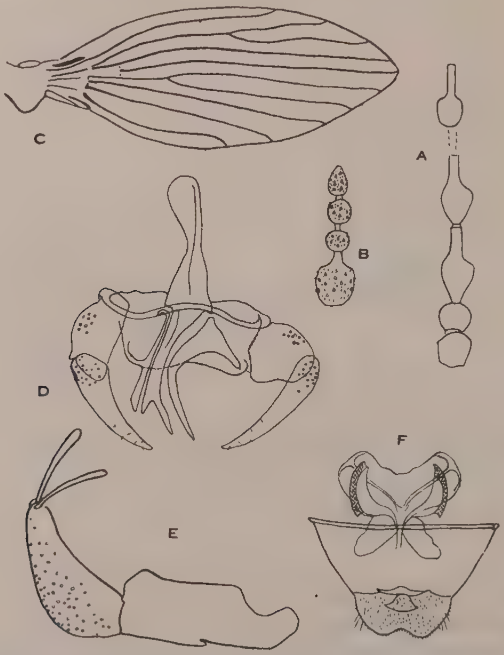

Fig. 9.—*Psychoda unimaculata*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, venation; *D*, hypopygium; *E*, cercopods; *F*, subgenital plate and spermathecae.

Thorax with ochraceous covering. Wing 1.9 mm long, with *Sc* thickened, radial fork after medial and a little before level of tip of *Cu*; origin of R_{2+3} well before apex of 1st basal cell, which is considerably longer than 2nd. Wing vestiture ochraceous, a tuft of brownish hairs over radial fork; a cluster of pale hairs with a white reflection at base of wing; fringe unicolorous. Legs unicolorous.

Abdomen with a sparse covering of long ochraceous hair, a tuft of whitish hair on dorsal surface of 1st abdominal segment. Hypopygium with 9th sternite (Fig. 9*D*) narrow and arched dorsally in the mid line, though not to such an extreme degree as in previous species; coxites longer than wide; style a little longer than coxite, evenly curved and tapered with a few scattered sensory setae near the tip; aedeagus complex consisting of (*a*) a median process, forked near tip, and arising as a continuation of the main part of the aedeagus; (*b*) a lateral sickle-shaped piece articulated to (*a*); and (*c*) a lateral rod connected to a transversely placed strut running behind (*a*) and (*b*). Cercopods (Fig. 9*E*) short and swollen basally, scarcely as long as 9th tergite, bearing 2 retinaculae slightly more than ½ as long as the cercopod.

Female

Similar to male, antennae shorter with smaller ascoids; subgenital plate and spermathecae as in Figure 9*F*; ovipositor 1.9 times as long as subgenital plate.

Type: Eaglehawk Neck, 15.xi.1922.
Allotype: Ferntree, 1.xi.1922.

PSYCHODA IRRORATA, sp. nov.

Fig. 10

Closely related to the previous species but distinguished from it by the presence of numerous tufts on the wings.

Male

Pale ochraceous tufts on face and between antennae. Eye bridges 4 facets wide, separated by width of ½ a facet. Antennae 16-segmented, twice as long as width of wing, uniformly pale ochraceous, verticils closed; scape 1.5 times as long as wide (Fig. 10*A*), basal flagellar segment amphora-shaped, with neck equal to bulb, neck longer than bulb in succeeding segments, bulb slightly eccentric (Fig. 10*B*); terminal 3 segments only ½ diameter of 13th; ascoids (Fig. 10*B*), in pairs on segments 3-13 with a single twisted anterior arm broadened at the base, and a long posterior arm. Palpi pale ochraceous (Fig. 10*C*), palpal formula 1 : 1.5 : 2 : 2.

Thorax with ochraceous covering. Wing 2 mm long (Fig. 10*D*), with R_5 at wing tip, *Sc* thickened, radial fork after medial, both before tip of *Cu*, origin of R_{2+3} well before apex of 1st basal cell, which is considerably longer than 2nd. Wing vestiture ochraceous with conspicuous blackish tufts over radial fork, base of M_2 where it joins M_3, base of R_5, and tip of *Cu*; less distinct blackish tufts at tips of other veins; an indistinct brownish transverse fascia extending from level of tip of R_3 to tip of M_3 and a 2nd, more proximal fascia starting at tip of R_1, extending back to include dark tuft on radial fork, reaching its posterior point on medial fork, and turning forwards to terminate at tip of *Cu*; dark fasciae extending onto fringe which is otherwise ochraceous. Legs pale ochraceous, dorsally washed with brown at apex of femur, tibia, and tarsal joints.

Abdomen with long pale ochraceous hair. Hypopygium with ninth sternite curved upwards medially (Fig. 10*E*); coxites longer than wide; style ½ as long again as coxite, evenly curved, and tapered to a pointed tip, with scattered sensory setae; aedeagus complex, consisting of (*a*) a tapering pointed piece forming a continuation of the main body of the aedeagus and bearing some minute teeth near the tip; (*b*) 2 sickle-shaped pieces, one of which is articulated to the main body of the aedeagus and has a pointed blade, and the other of which lies to one side and is more bluntly pointed; and (*c*) a lightly sclerotized rod which is a process of the pointed sickle-shaped element; cercopods as long as the 9th tergite (Fig. 10*F*), tapering evenly with a single retinaculum of great length equal to 2/3 length of cercopod.

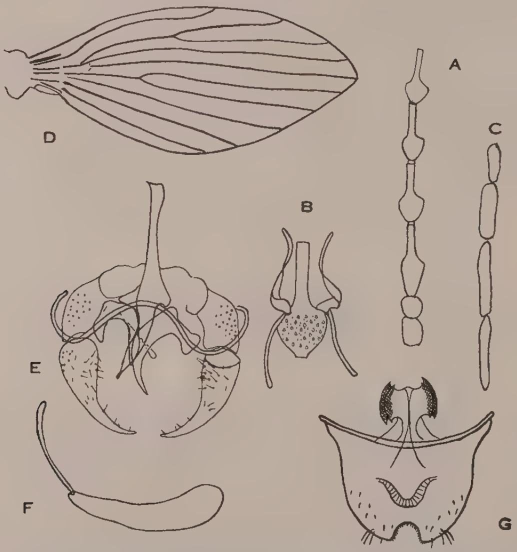

Fig. 10.—***Psychoda irrorata,*** **sp. nov. *A,* base of antenna; *B,* 5th antennal segment; *C,* palp; *D,* venation; *E,* hypopygium; *F,* cercopod; *G,* subgenital plate and spermathecae.**

Female

Similar to male but ascoids rather smaller; subgenital plate (Fig. 10*G*) rather more rounded in contour than in previous species; spermathecae as in Figure 10*G*; ovipositor short, 1.6 times as long as subgenital plate.

Type, allotype, and 6 ♂, 1 ♀ paratypes: Burnie, 27.x.1922. 1 ♂ paratype, Mt. Hicks, 20.x.1933.

Other specimens: 1 ♂, 2 ♀, Fitzroy Falls, 22-27.xi.1937.

The Fitzroy Falls specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

Psychoda truncata, sp. nov.

Fig. 11

A uniformly ochraceous species with a much reduced ovipositor, known only in the ♀ sex.

Female

Eye bridges separated by width of 1 facet. Antennae 16-segmented, 1.6 times as long as width of wing, uniformly pale ochraceous, verticils closed, scape 1.5 times as long as broad (Fig. 11*A*); basal flagellar segment with neck equal to bulb, but increasing in length in succeeding segments; terminal 3 segments and ascoids, as in *Psychoda subpennata,* sp. nov. Palpal formula 1 : 1.5 : 1.5 : 1.8 (Fig. 11*B*).

Thorax with ochraceous hairy covering; wing (Fig. 11*C*) 2.2 mm long, radial fork after medial, both before level of tip of *Cu*; origin of R_{2+3} on R_4 almost at apex of 1st basal cell, which is a little longer than the 2nd.

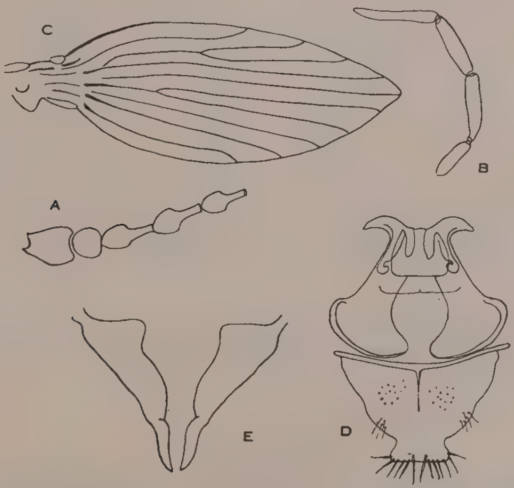

Fig. 11.—*Psychoda truncata,* sp. nov. *A,* antenna base; *B,* palp; *C,* venation; *D,* subgenital plate and spermathecae; *E,* ovipositor.

Subgenital plate (Fig. 11*D*) truncate at apex, bearing strong sensory setae along its posterior margin; spermathecae of characteristic shape, without reticulate markings on central capsules; ovipositor very much reduced so that the blades are shorter than the basal portions, which encircle the tip of the abdomen (Fig. 11*E*).

Type and 1 ♀ paratype: Ferntree Gully, 25.x.1921.

This species has such distinct female genitalia that it seems worth describing even though it is known only from the female sex.

PSYCHODA PENICILLATA Satchell

Psychoda penicillata Satchell, 1950, Trans. R. Ent. Soc. Lond. **101**: 176-7.

This New Zealand species gives its name to what I have termed the "*penicillata* complex." Here are grouped a number of species in which the wing venation is identical and the genitalia are extremely similar, the style having a shape and arrangement of setae on it which is common throughout the group. The male is frequently adorned with tufts of squamuliferous hairs. *P. penicillata* has a pencil of such hairs on the under side of the wing, carried on a reflected flap from the costal pad, and the entire abdomen has the hairs replaced by tufts of scales. In *P. subpennata* the costal tuft is much shorter and narrower, in *P. squamata* it is diffuse and bushy. In *P. arcuata* and *P. squamipleuris* the wing has the hairs of the under surface replaced by scales in the basal portion. In *P. apennata* and *P. ypsylon*, the wing does not bear any of the scale tufts seen in the others. It is certain that there are many undescribed members of the *penicillata* complex, for notes on 3 other species are present in the Tonnoir manuscript. Unfortunately no specimens of these 3 are in the collection, so descriptions of them cannot be given. *Psychoda cinerea* Banks, a cosmopolitan species present also in Australia, is a member of the *penicillata* complex, but one which, like *P. ypsylon*, lacks the adornments of scale tufts found in many of the others. At the moment it is impossible to separate the females of the *penicillata* complex with any certainty. It may be that differences exist in the spermathecae, but it is not possible to use these on Tonnoir's specimens. Such differences if present, will be slight, and will only be apparent if a uniform method of mounting is adopted. In the existing specimens possible specific differences are masked by the diverse appearances that mounts may have owing to different position of mounting and different degrees of compression of the specimens.

P. penicillata is clearly a widespread species in Australia, specimens in the collection having been taken in Tasmania, Victoria, New South Wales, and Western Australia.*

PSYCHODA SUBPENNATA, sp. nov.

Fig. 12

A greyish brown species closely related to *P. penicillata*, but lacking scales on the ♂ abdomen.

Male

A tuft of erect greyish ochraceous hairs on face; eye bridges 4 facets wide, separated by width of 1 facet. Antennae (Fig. 12*A*) 16-segmented, 1.5 times width of wing, uniformly ochraceous with closed verticils; scape 1.2 times as long as broad; covered with ochraceous scales, basal flagellar segment with neck equal to bulb; increasing in length in subsequent segments until it is 1.2 times as long, in segment 10; terminal 3 segments subspherical, diminutive, well separated (Fig. 12*B*), ascoids of usual Y type on segments 3-13. Palpi with ochraceous scaly covering (Fig. 12*C*); palpal formula 1 : 1.4 : 1.6 : 2.

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* This species has since been found to be widely distributed in South Africa (G.H.S.).

Thorax with mainly hairy covering. Wing 1.7 mm long (Fig. 12*D*); radial fork after medial, both before tip of *Cu*; origin of R_{2+3} arising on R_4 at a distance from apex of 1st basal cell equal to width of that cell. Wing covering uniformly ochraceous, a straight pencil of hairs, borne on a reflected flap at base of costa, extending under wing to apex of 1st basal cell.

Abdomen lacking tufts of scales on dorsum, vestiture of long ochraceous hair. Hypopygium (Fig. 12*E*) with 9th sternite characteristically shaped, not prolonged backwards at outer edges. Coxite longer than wide, style ½ as long again as coxite; swollen basally, curved and tapering; a long seta inserted near base, a patch of sensory setae further round; and some scattered sensory setae on the distal part; aedeagus of 1 curved, pointed element and 1 straight, blunt one; a single conical pilose lobe ventral to aedeagus. Cercopods (Fig. 12*F*) 1.8 times length of 9th tergite; retinaculum single, 0.4 length of cercopod.

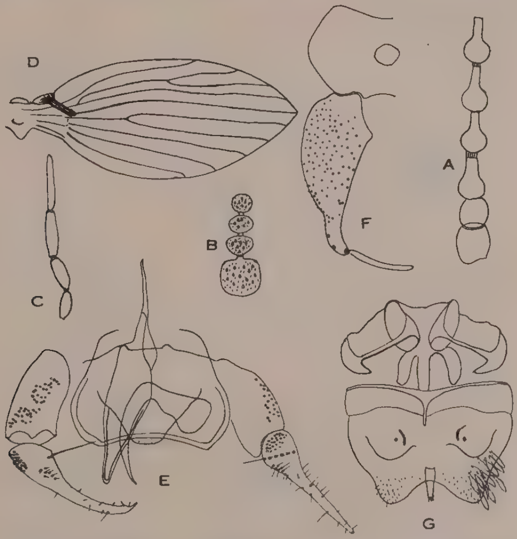

Fig. 12.—*Psychoda subpennata*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, palp; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, subgenital plate and spermathecae.

Female

Similar to ♂ but lacking pencil of hairs on wing. Subgenital plate (Fig. 12*G*) with squamuliferous hairs on lateral margins; without prominent lateral lobes; genital digit truncated at tip, bearing 3 minute setulae, broad, projecting well beyond edge of plate. Spermathecae as in Figure 12*G*; ovipositor 2-2.3 times as long as subgenital plate.

Type, allotype, and 5 ♂, 3 ♀ paratypes: Kangaroo Valley, 11.ii.1933. 1 ♀ paratype, 12 ♀ other specimens, Fitzroy Falls, 22-27.xi.1937. 1 ♀, Mt. Kembla, 12.ii.1933. 1 ♂, 1 ♀, Burnie, 21.x.1933.

One of the ♂ paratypes, and 2 ♀ specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

PSYCHODA SQUAMATA, sp. nov.

Fig. 13

Related to the previous species but with different genitalia.

Male

Eye bridges 3 facets wide, separated by width of 2 facets. Antennae (Fig. 13*A*) 1.7 times as long as wing width, verticils closed; scape 1.8 times as long as broad; basal flagellar segment with neck a little shorter than bulb; increasing in length in subsequent segments until it is 1.2 times as long in segment 10 (Fig. 13*B*); terminal 3 segments (Fig. 13*C*), subspherical, diminutive, well separated; ascoids of usual Y type on segments 3-13. Palpal formula 1 : 1.3 : 1.4 : 1.8 (Fig. 13*D*).

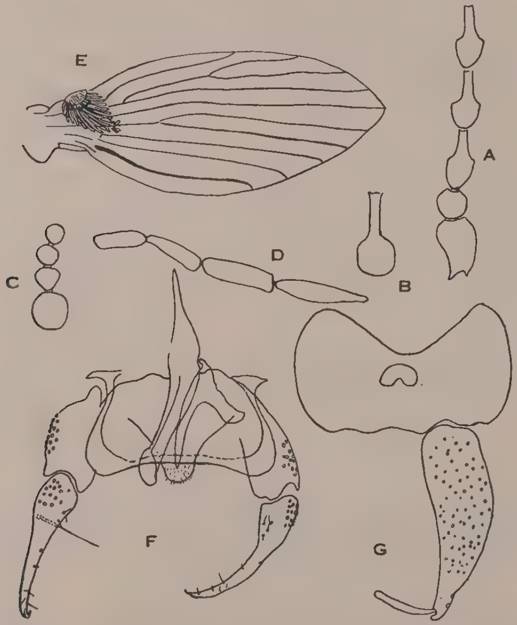

Fig. 13.—*Psychoda squamata*, sp. nov. *A*, base of antenna; *B*, 10th antennal segment; *C*, tip of antenna; *D*, palp; *E*, venation; *F*, hypopygium, *G*, cercopod.

Thorax with a covering of long hair apart from a tuft of long scales below wing base. Wing (Fig. 13*E*) 1.8 mm long, radial fork after medial, both well before tip of *Cu*; R_{2+3} arising on R_4 well past apex of 1st basal cell; pad at base of costa with a reflected flap bearing a cluster of curved scales reaching to base of medial, on base of which some small scales occur; remainder of wing with hairy vestiture.

Abdomen with squamuliferous hairs on sides only, dorsum with normal hair. Hypopygium with 9th sternite shaped as in Figure 13*F*; coxite longer than wide, style 1.5 times length of coxite, curved, tapered, pointed at tip; a long seta inserted basally and 4 or so small sensory setae inserted further round; scattered sensory setae in distal part. Aedeagus of 2 parts, the median ending in a knob-like protuberance, the curved piece as in related species; a single median, pilose lobe below the aedeagus. Cercopods as in related species, almost twice length of 9th tergite (Fig. 13*G*) with a single retinaculum 0.4 length of cercopod.

Type and only specimen: Cradle Valley, 20.i.1923. The single specimen has been dissected. Tonnoir in his notes says of it that it is ochraceous-brown, and mentions the squamuliferous hairs on the abdomen; these features are not visible in the dissected specimen.

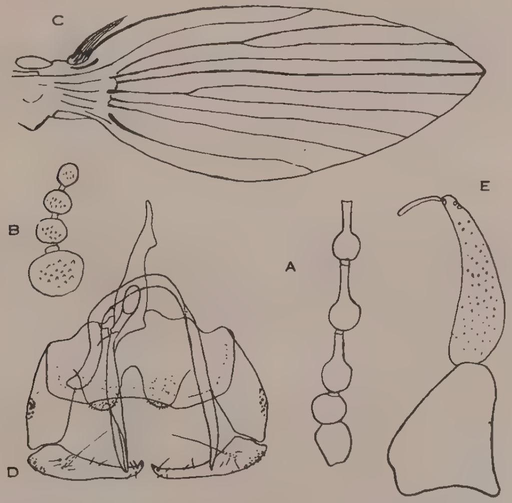

Fig. 14.—*Psychoda arcuata*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, venation; *D*, hypopygium; *E*, cercopod.

PSYCHODA ARCUATA, sp. nov.

Fig. 14

Closely related to previous species but distinguished by the scales on the ventral surface of the male wing, and the distinctive male genitalia.

Male

Eye bridges 4 facets wide, separated by width of 1 facet. Antennae 16-segmented, 1.6 times wing width, scape (Fig. 14*A*) 1.3 times as long as broad; basal flagellar segment with neck a little longer than bulb; increasing in length in subsequent segments until it is 1.2 times as long in segment 10; terminal 3 segments subspherical, diminutive, well separated (Fig. 14*B*); ascoids of usual Y type on segments 3-13. Palpal formula 1 : 1.4 : 1.7 : 2.

Thorax with hairy vestiture. Wing (Fig. 14*C*) 2.1 mm long; radial fork after medial, both well before tip of *Cu*; origin of R_{2+3} at apex of 1st basal cell, which is a little longer than the 2nd; pad at base of costa bearing a tuft of long hair lying parallel with costal fringe; pad with a ventrally reflected fringe of short scales; wing veins covered with scales on ventral surface in basal third of wing.

Abdomen with hairy vestiture. Hypopygium with 9th sternite shaped as in Figure 14*D*; coxite longer than wide, style subequal to coxite, slightly curved, with a sharply pointed curved tip; a large seta near base of style, and some scattered setae on the distal part; aedeagus with the usual 2 elements widely separated, the curved one being displaced laterally; paired pilose lobes ventrally; cercopods (Fig. 14*E*) only slightly longer (1.1) than 9th tergite, with a single retinaculum ¼ the length of the cercopod.

Type and only specimen: Ferntree, 1.xi.1922. The type specimen has been dissected and mounted on slides, so it is not possible to record features of coloration. Tonnoir in his MSS notes on this species says it is "pale ochraceous-brown."

PSYCHODA SQUAMIPLEURIS, sp. nov.

Fig. 15

A rather variable greyish brown species with tufts of short scales in front of and behind the wing base in the male and with a varying proportion of the base of the under surface of the male wing covered with scales.

Male

Head with a dense erect tuft of ochraceous squamuliferous hairs on face and an even covering of shorter scales on the vertex forming a fringe overhanging the eyes. Eye bridges 4 facets wide, separated by width of 1.5 facets. Antennae 16-segmented, 1.8 times width of wing, uniformly ochraceous with closed verticils; scape (Fig. 15*A*) 1.8 times as long as broad, basal flagellar segment with neck a little longer than bulb, increasing in length in succeeding segments until it is 1.3 times as long as bulb in segment 12 (Fig. 15*B*); last 3 segments diminutive, subspherical, and well separated, ascoids of usual Y type on segments 3-13. Palpi ochraceous, palpal formula 1 : 1.5 : 1.9 : 2.

Thorax with an anterior band of squamuliferous hairs with shorter scales intermixed, extending round the sides and giving way dorsally to a hairy vestiture; a prominent tuft of small scales appearing blackish in certain lights, present both in front of and behind the wing base, both tufts being mounted on slightly protuberant regions of the pleura. Wing (Fig. 15*C*) 2 mm long, radial fork after medial, both before tip of *Cu*; origin of R_{2+3} after apex of 1st basal cell, which is a little longer than the 2nd; no recurved flap at base of costa; hairs on veins on under surface of wing replaced by scales to a varying extent but generally on the basal 1/5 of wing; scales particularly dense at base of costa and R_4.

Abdomen with tufts of squamuliferous hairs laterally, replaced by normal hairy vestiture dorsally. Hypopygium (Fig. 15*D*) with 9th sternite narrow; coxite longer than wide, style swollen basally and shaped as in Figure 15*E* when seen in profile; aedeagus consisting of 2 pieces, one much curved and fitting within a groove on the ventral surface of the other, the appearance of the aedeagus differing according to the extent to which the 2 pieces have become separated in mounting; a single rectangular pilose lobe present ventrally. Cercopod (Fig. 15*F*) 1.4 times as long as 9th tergite, but length rather variable, retinaculum single, 0.3 length of cercopod.

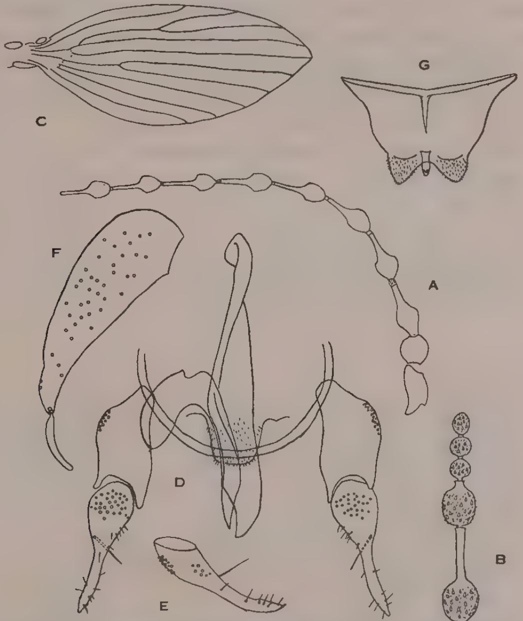

Fig. 15.—*Psychoda squamipleuris*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, venation; *D*, hypopygium; *E*, style; *F*, cercopod; *G*, subgenital plate.

Female

Similar to male but lacking squamuliferous hairs and scales on wing, thorax, and abdomen. Subgenital plate as in Figure 15*G*, with no squamuliferous hairs on sides of plate, and the genital digit generally club-shaped but sometimes simply conical; spermathecae as in previous species, ovipositor 2.2 times length of subgenital plate.

Type: Black Mountain, July 1931.

Allotype: Canberra, Oct. 1930.

♂ Paratypes: Mt. Wilson, 19.xi.1921. Broomhill, 12.viii.1937, K. R. Norris. Eaglehawk Neck, 20.xi.1922. Crawley, 2.vii.1934, K. R. Norris. Sassafras, 20.x.1922. Canberra, 16.iv.1930. One ♂ with allotype.

♀ Paratypes: Two with allotype, 1 with type. Also Yass, 13.vii.1930, Miss K. English.

Other specimens: 3 ♂, 3 ♀, Yass, Aug. 1931, Miss K. English. 7 ♀ with allotype, 1 ♀, Canberra, 11.xii.1929, G. F. Hill. 1 ♀, Canberra, Jul. 1932, M. Fuller. 1 ♀, Snowy River, 10-15.ii.1934. 1 ♀, Pemberton, 25.xi.1936, K. R. Norris. 1 ♀, Crawley, 12.vi.1934, K. R. Norris.

In his manuscript notes Tonnoir described a species *P. squaminervis,* which he considered to be distinct from *P. squamipleuris.* However, an examination of additional material that clearly came into the Tonnoir collection subsequent to his drawing up the manuscript descriptions of these 2 species has broken down the supposed distinctions between them and I have regarded them as one. Further studies on a wider range of material, including the early stages, may indicate that the rather variable assemblage grouped under the *P. squamipleuris* label may have to be split into a number of species, but it is impossible to do this satisfactorily with the existing specimens.

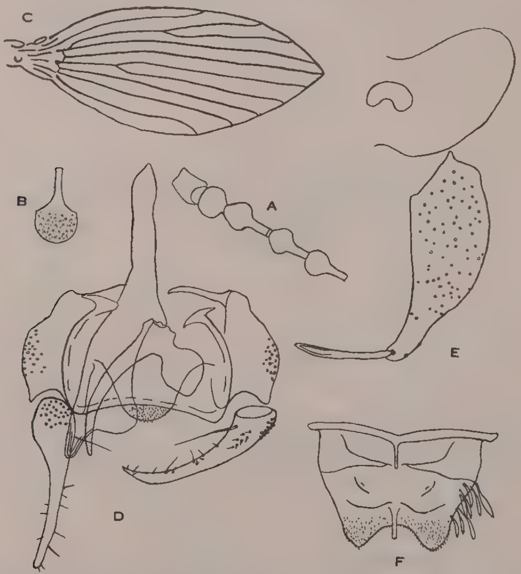

Fig. 16.—*Psychoda apennata,* sp. nov. *A,* antenna base; *B,* 10th antennal segment; *C,* venation; *D,* hypopygium; E, cercopod; F, subgenital plate.

PSYCHODA APENNATA, sp. nov.

Fig. 16

A brownish species near to *P. subpennata* but lacking any trace of a tuft at the base of the ♂ costa, and possessing a small tuft of squamuliferous hairs on the anterior dorsal pleura.

Male

Decumbent tuft of hairs on clypeus, erect tuft on face. Eye bridges 4 facets wide, separated by width of 1 facet. Antennae ochraceous with slightly open verticils, 1.4 times length of wing; scape (Fig. 16*A*) 1.1 times as long as wide; basal flagellar segment with neck slightly longer than bulb, increasing in length until it is 1.2 times as long in segment 10 (Fig. 16*B*); terminal segments and ascoids as in related species. Palpi with ochraceous scaly covering; formula not investigated.

Thorax with mainly hairy vestiture dorsally; a small dense tuft of squamuliferous hairs on pleura above anterior spiracle, and a few scattered squamuliferous hairs below wing base. Wing (Fig. 16*C*) 1.9 mm long; radial fork after medial, both before tip of *Cu*; origin of R_{2+3} on R_4 only a little past apex of 1st basal cell, which is longer than 2nd basal cell; no tuft at base of costa; wing vestiture hairy.

Abdomen with an ochraceous hairy vestiture, lacking squamuliferous hairs. Hypopygium with 9th sternite (Fig. 16*D*) curved and rounded at the corners; coxites longer than wide, style very similar to that of *P. subpennata*; aedeagus with main piece bearing a flattened shelf-like plate along its length; curved piece much as in related species; a single median pilose lobe ventrally; cercopod 2.3 times length of 9th tergite, shaped as in *P. subpennata,* bearing a single retinaculum 0.45 times length of cercopod.

Female

Similar to male but lacking scales on the pleura; subgenital plate (Fig. 16*E*) without prominent lateral lobes, bearing some squamuliferous hairs on the sides; genital digit narrow, cylindrical, projecting beyond posterior margin of plate. Spermathecae as in *P. subpennata*; ovipositor twice as long as subgenital plate. The ♀ of this species is only distinguished from that of *P. penicillata* and *P. subpennata* by the narrow genital digit, and even this difference is dubious since the relative length and thickness of this structure are sometimes rather variable.

Type, allotype, and 3 ♂, 2 ♀ paratypes: Burnie, 21.x.1933.

Paratypes: 1 ♂, Macquarie Pass, 23.xii.1934. 1 ♂, National Park, Tasmania, 15.xii.1922.

Other specimens: 1 ♀ with type: 5 ♀, Weldboro Pass, 25.x.1933. 2 ♀, Hobart, 29.x.1933.

Tonnoir had not provided a name for this species, nor were there any manuscript notes on it.

PSYCHODA YPSYLON, sp. nov.

Fig. 17A-G

A small greyish ochraceous species with elongate cercopods.

Male

Eye bridges 4 facets wide, separated by the width of 1 facet. Antenna (Fig. 17*A*) 1.6 times as long as width of wing; scape 1.3 times as long as broad, basal flagellar segment with neck equal to or slightly longer than bulb, increasing in length in subsequent segments until it is 1.6 times as long in segment 12 (Fig. 17*B*); terminal 3 segments (Fig. 17*C*) diminutive, subspherical, well separated; ascoids (Fig. 17*B*) 3-branched with well-developed anterior arms on segments 3-13. Palpi (Fig. 17*D*) with ochraceous scaly covering; palpal formula 1 : 1.3 : 1.7 : 1.7.

Thorax with a hairy covering; wing (Fig. 17*E*) 1.6 mm long, radial fork after medial, both before level of tip of *Cu*; origin of R_{2+3} on R_4 a little past apex of 1st basal cell, which is distinctly longer than 2nd; wing covering uniformly ochraceous and hairy.

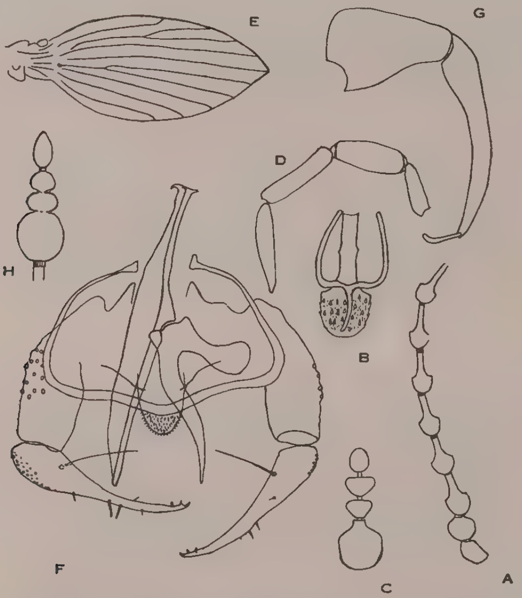

Fig. 17.—*A-G, Psychoda ypsylon*, sp. nov.; *H, Psychoda makati* Del Rosario. *A*, base of antenna; *B*, 12th antennal segment; *C*, tip of antenna; *D*, palp; *E*, venation; *F*, hypopygium; *G*, cercopod (diminished by half compared with *F*); *H*, antenna tip.

Abdomen with a vestiture of ochraceous hairs. Hypopygium (Fig. 17*F*) with 9th sternite slightly bent out posteriorly; coxite longer than wide, style with an indication of a rather more sudden tapering 1/3 distance from base; a large seta near base and 2 short, thick setae occurring ½ way along style. Aedeagus with 1 straight and 1 curved piece, the former with a straight rod of thickening extending down its length, the latter with a tendency to adopt an S-shaped outline, rather than the customary C shape; a single median pilose lobe ventral to aedeagus; cercopods (Fig. 17*G*) thin, elongate, swollen basally, 1.9 times as long as 9th tergite, bearing a single retinaculum 1/5 as long as cercopod.

Type and 2 ♂ paratypes: Ferntree, 12.xi.1922, 25.x.1921. ♂ Paratypes: Sassafras, 19.x.1922. St. Patrick's R., 31.x.1922. Narara, 3.xi.1921.

Genus TRICHOPSYCHODA Tonnoir

Trichopsychoda Tonnoir, 1922, Ann. Ent. Soc. Belg. 62: 59.

TRICHOPSYCHODA MONTANA, sp. nov.

Fig. 18

This species was partially described by Tonnoir in his notes and is of great interest as it adds a 2nd species to the genus. To date the genus is known only from the type species, *T. hirtella* Tonn. Tonnoir mentions a 2nd Australian species in his notes, but this cannot be described as it is unrepresented in the collection. It is doubtful if the genus is at all closely related to *Psychoda,* the genitalia being very different. It is reminiscent of *Brunettia* Annandale in the presence of hairs on the wing membrane, whilst the curious bell-like retinaculae are similar to those found in such species as *Brunettia splendens* Tonn. Its affinities will remain obscure until the overlapping generic concepts centred around *Brunettia, Telmatoscopus, Psychoda,* and *Pericoma* have been revised.

As no types were selected by Tonnoir, I have established a type, allotype, and 4 ♂ paratypes.

A uniformly dark brown species with 2 slightly darker tufts near the wing base.

Male

A tuft of erect brown hairs on face and between antenna. Eye bridges separated by width of 1.5 facets. Antennae 15-segmented, 1.6 times as long as width of wing; scape, pedicel, and flagellar verticils brown, verticils closed; scape (Fig. 18*A*) scarcely as long as wide, pedicel subequal to scape, basal flagellar segments with neck a little shorter than spherical bulb, equal to bulb in medial segments (Fig. 18*B*); 14th small, 15th smaller still, separated from 14th by a short neck (Fig. 18*C*); ascoids in pairs on segments 3-13, of Y type but with unequal anterior arms. Palpi with an even brown vestiture, palpal formula 1 : 1.5 : 1.9 : 2.5.

Thorax with a dense covering of brown hairs paler towards the base. Wing (Fig. 18*D*) with R_5 at apex; medial and radial forks incomplete, free inner end of M_2 just before level of tip of *Cu;* free inner end of R_3 just after level of tip of R_1; origin of R_2 at apex of 1st basal cell, which is considerably longer than the 2nd. Wing with veins and membrane covered with an even vestiture of brown hairs with coppery reflection; erect hairs present on basal 1/3 of wing, on veins R_2, R_4, M_1, M_3, and *Cu*; erect hairs at outer end of row on R_2 forming a darker tuft; a less conspicuous darker tuft present at base of R_4; fringe unicolourous. Legs uniformly brown.

Abdomen with long brown hairs. Hypopygium with 9th sternite (Fig. 18*E*) characteristically shaped with posteriorly directed lateral lobes and a median transverse bar; coxite longer than wide; style blunt, a longitudinal furrow marking off a terminal blade-like portion from the rest (Fig. 18*F*), style bearing scattered sensory hairs; aedeagus symmetrical, bluntly pointed, with inrolled lateral margins, shaped as in Figure 18*E* when seen in lateral view; cercopods (Fig. 18*G*) bulbous at base, bluntly pointed at apex, bearing a dorsal cluster of 10 or so retinaculae with fringed tips, the proximal ones being the longest; a sclerotized process present, lateral to the cluster of retinaculae, bearing 2 long retinaculae with bell-like tips (Fig. 18*H*).

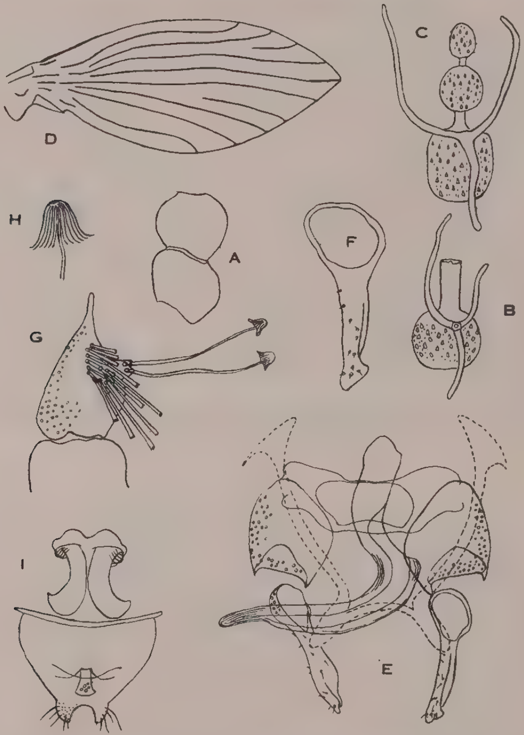

Fig. 18.—*Trichopsychoda montana*, sp. nov. *A*, scape and pedicel; *B*, medial flagellar segment; *C*, antenna tip; *D*, venation; *E*, hypopygium; *F*, style (enlarged); *G*, cercopod; *H*, bell-like retinaculum; *I*, subgenital plate and spermathecae.

Female

Similar to male; subgenital plate (Fig. 18*I*) shield-shaped with very small terminal lobes bearing some prominent lateral setae; genital digit shaped like a pestle, with 5 circular sensillae on it; spermathecae of simple design, similar to the type found in *Brunettia*; ovipositor very short, 1.25 times as long as subgenital plate.

Type, allotype, and 2 ♂ paratypes: Mt. Wilson, 9.xi.1921.

Paratypes: 1 ♂, Mt. Farrel, 9.ii.1923. 1 ♂, Burnie, 1.ii.1923. 1 ♀, Strahan, 6.ii.1923.

The paratype ♀ is in the Division of Entomology Museum, C.S.I.R.O., Canberra.

T. montana differs from the type species in the reduced number of bell-like retinaculae.

Genus TELMATOSCOPUS Eaton

***Telmatoscopus* Eaton, 1904, Ent. Mo. Mag. (2) 15: 58.**

The genus *Telmatoscopus* was erected by Eaton (1900) to contain species formerly belonging to his sections 3*c*, 3*d*, and 4*a* of *Pericoma,* and Tonnoir (1933) considers that *T. morula* Eaton should be considered the type species. The genus contains Psychodidae in which the antennae are 16-segmented (very occasionally 15-segmented), the flagellar segments possess necks, the last 3 segments are not diminutive, and the wing bears hairs or scales on the veins only, and not on the wing membrane.

The genus is a large one and amongst the material represented in the Tonnoir collection are 2 species in which the eyes lack bridges, and do not extend above the base of the antennae. They are also characterized by distinctive genitalia in both sexes and they will be assigned to a new subgenus, *Paratelmatoscopus.* Thirteen of the remaining 15 species fall into 2 natural assemblages characterized by the presence or absence of erect hairs on R_1. Species possessing erect hairs on R_1 will be assigned to a new subgenus, *Nototelmatoscopus*; in this will be included *T. obscurus,* sp. nov., *T. crassepalpis,* sp. nov., *T. festivus,* sp. nov., *T. nicholsoni,* sp. nov., *T. viduatus,* sp. nov., *T. gregsoni,* sp. nov., and *T. dimorphus,* sp. nov. Species in which erect hairs are absent from R_1 will be assigned to a new subgenus, *Eutelmatoscopus*; in this will be included *T. neglectus,* sp. nov., *T. fordi,* sp. nov., *T. norrisi,* sp. nov., *T. confusus,* sp. nov., *T. aberrans,* sp. nov., and *T. spiralifer,* sp. nov. *T. townsvillensis* Taylor, which Tonnoir describes in further detail in Part II, is unfortunately only represented by 7 rather damaged specimens. I am leaving a statement of its subgeneric affinities until more material is available. It is apparently a very common species (Priestly, personal communication to A. L. Tonnoir 1922). Similarly *T. poncianicolus,* sp. nov., stands rather apart and is only represented by rather fragmentary material. It shares with *T. townsvillensis* Taylor the curiously differentiated body hairs with the nipple-like tips, but otherwise differs from its very considerably. Its subgeneric status must be left unsettled until more material is available.

Subgenus PARATELMATOSCOPUS, subgen. nov.

Eyes not extended as bridges above bases of antennae; antenna 16-segmented, basal flagellar segment oval and quite without a neck; ascoids simple, paired, and curved; radial sector strongly pectinate, R_5 ending at wing tip; aedeagus inflated, balloon-like; subgenital plate of ♀ with processes directed medially, spermathecae with a characteristic shape. Type species *Telmatoscopus variegatus,* sp. nov.

Telmatoscopus (Paratelmatoscopus) variegatus, sp. nov.

Fig. 19

A moderate-sized species with 3 white spaces in the wing fringe.

Male

Clypeal tuft of decumbent, bronzy hairs; tuft of erect dark brown hairs on frons below antennae, and of white erect hairs on frons between antennae and extending onto epicranium. Eyes not extending above antennae bases (Fig. 19*A*) so eye bridges completely lacking; antennae 1.6 times as long as width of wing; flagellum greyish brown with open verticils; pedicel and scape with a scanty covering of light brown scales apart from a ring of white scales on distal end of pedicel and inner side of scape; scape (Fig. 19*B*) 1.6 times as long as wide, pedicel subspherical, a little longer than wide; 1st flagellar segment lacking a neck, 2nd flagellar segment with neck a little shorter than bulb; succeeding segments with neck equal to bulb, which is itself longer than wide; terminal segment (Fig. 19*C*) with a club-shaped apiculus shorter than the bulb; ascoids paired, simple, long, and much curved on segments 4-16; paired sensory cones inserted on side of each ascoid-bearing segment. Palpi (Fig. 19*D*) with a scanty covering of bronzy scales; palpal formula 1 : 2.2 : 1.7 : 2.

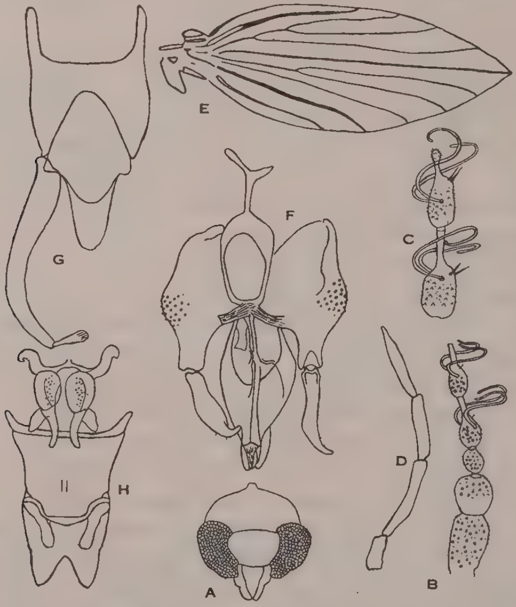

Fig. 19.—*Telmatoscopus variegatus*, sp. nov. *A*, head showing eyes; *B*, base of antenna; *C*, tip of antenna; *D*, palp; *E*, venation; *F*, hypopygium; *G*, cercopod; *H*, subgenital plate and spermathecae.

Thorax with covering of light brown hairs; white tufts in front of wing base and some white hairs in mid line; no allurement organ present. Wing 2.5 mm long (Fig. 19*E*), lanceolate, R_5 at wing tip; *Sc* very short and thick, R_1 thick, but almost free of sclerotization in basal 1/3; *Rs* markedly pectinate, the origin of R_4 being closer to radial fork than to base of R_{2+3+4}; radial fork and medial fork both well before middle of wing; basal cells equal. Wing vestiture mainly bronzy; erect hairs absent on R_5 and on M_4 apart from a tuft of white erect hairs at tip; erect hairs on other veins extending to tip, terminating in a white erect tuft; some whitish erect hairs towards centre of wing disc and others over the wing base, darker erect tuft over medial fork; elsewhere bronzy. Fringe bronzy apart from 3 whitish spaces, 1 at the wing apex, 1 at the end of M_2, and 1 between the ends of M_4 and *Cu*. Legs with mainly scaly covering.

Abdomen with bronzy vestiture apart from paired white tufts at base of abdomen and a ventral white patch over genitalia. Hypopygium (Fig. 19*F*) with coxites longer than broad, bearing a lateral patch of hairs; style shorter than coxite, bluntly pointed, and curved at tip, lacking any lateral tuft of hairs. Parameres apparently absent; in fact embracing aedeagus, which has an inflated, balloon-like appearance, terminating in a conical element. Cercopods (Fig. 19*G*) forficulate, longer than 9th tergite, gently tapered, ending in a single spoon-like retinaculum; anal flap long and scoop-shaped.

Female

Similar to male but antennae shorter; subgenital plate bearing haired processes which do not terminate in sclerotized tips, and are widely separated in the mid line (Fig. 19*H*), spermathecae of complex design (Fig. 19*H*) with a little punctate sculpturing on the chambers; ovipositor 1.6 times as long as subgenital plate.

Type: Mt. Wellington, 25.xi.1922.

Allotype: Geeveston, 8.xii.1922.

Paratypes: 2 ♂, Eaglehawk Neck, 14, 15.xi.1922. 1 ♂, Strahan, 6.ii.1923. 1 ♂, St. Patrick's River, 30.x.1922. 2 ♀, Ferntree, 25.x.1921. 2 ♀, 2 ♂, Burnie, 25, 27.x.1922, 22.xi.1922, 27.x.1933. 2 ♀, Fitzroy Falls, 22-27.ii.1937.

Other specimens: 1 ♀, Narara, 5.xi.1921. 1 ♂, Palm Beach, R. J. Tillyard, 22.x.1917.

A ♂ and ♀ paratype are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

TELMATOSCOPUS (PARATELMATOSCOPUS) SUBVARIEGATUS, sp. nov.

Fig. 20

Closely related to *T. variegatus*, differing from it chiefly in the position of the wing forks and character of the genitalia.

Male

Head vestiture, antennae, and palpi as in *T. variegatus*.

Thorax with rather more white hairs; wing longer in proportion to its width (2.3 mm); radial fork immediately above or even after medial but definitely not before (Fig. 20*A*): R_1 with basal lightly sclerotized area less extensive, vestiture as in previous species except that rather more white hairs are present. Legs and abdomen as in previous species.

Hypopygium as in previous species, but aedeagus (Fig. 20*B*) with the central unsclerotized area enclosed by enveloping parameres more extensively developed; cercopods (Fig. 20*C*) proportionately longer; retinaculum longer compared with cercopod; anal flap terminating more squarely.

Female

As in previous species but subgenital plate (Fig. 20*D*) not so deeply emarginate; paired processes of plate reaching further towards its posterior margin, almost meeting in the mid line, terminating in thimble-like sclerotizations.

Type, allotype, and 1 ♂ paratype: Mt. Wilson, 19.xi.1921.

Paratypes: 1 ♂, 1 ♀, Narara, 8.xi.1921. 1 ♀, Mt. Kembla, 12.ii.1933. 1 ♂, Fitzroy Falls, 22-27.xi.1937. 1 ♀, Narara, 8.xi.1921.

There is a single damaged specimen of a third species belonging to the subgenus *Paratelmatoscopus*, but no description of it can be given.

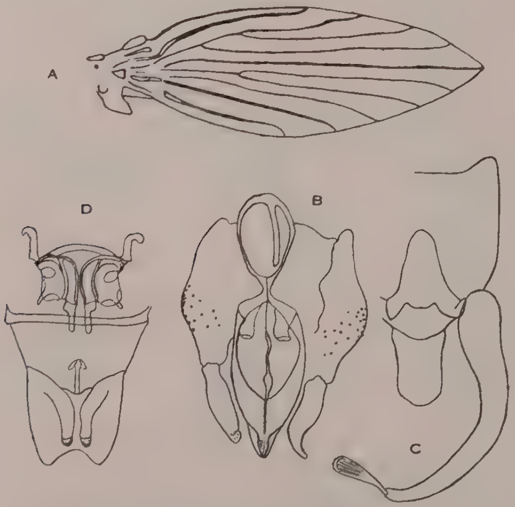

Fig. 20.—*Telmatoscopus subvariegatus*, sp. nov. *A*, venation; *B*, hypopygium; *C*, cercopod; *D*, subgenital plate and spermathecae.

TELMATOSCOPUS PONCIANICOLUS, sp. nov.

Fig. 21

A greyish brown species with a dark transverse fascia across the wing and the vestitural hairs with a narrow tip which appears dark by transmitted light (Fig. 21*A*) but whitish by direct light.

Male

Clypeal tuft of decumbent greyish hairs; frontal tuft of blackish brown erect hairs; vertex with dense tuft of blackish brown erect hairs. Eye bridges 4 facets wide, separated by width of 1 facet. Antennae 1.3 times as long as width of wing; scape covered with blackish brown scales, pedicel with a ring of whitish scales, flagellum greyish; scape nearly 3 times as long as wide, pedicel subspherical; basal flagellar segment with scarcely any neck (Fig. 21*B*) succeeding ones with longer necks, almost equalling bulbs in middle segments. Terminal segment with a club-shaped apiculus longer than the bulb (Fig. 21*C*). Paired multibranched ascoids on segments 3-16 (Fig. 21*D*); 1 or 2 simple sensory cones present in addition. Maxillary palpi with a greyish scaly vestiture.

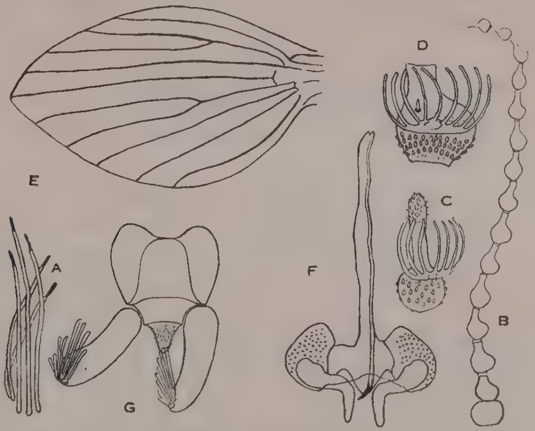

Fig. 21.—*Telmatoscopus poncianicolus*, sp. nov. *A*, body hairs; *B*, antenna; *C*, apical segment; *D*, basal segment of flagellum; *E*, venation; *F*, hypopygium; *G*, cercopod.

Thorax with no allurement organ present. Vestiture of whitish hairs interspersed with blackish ones with whitish tips. Wing ovolanceolate 1.8 mm long (Fig. 21*E*), R_5 at wing tip, radial fork before medial, both before tip of *Cu*; base of R_{2+3} joining R_4 well before apex of 1st basal cell, which is considerably longer than second; *Cu* not meeting M_4 basally. Wing vestiture brownish near base, whitish up to level of fork, a blackish brown transverse fascia occurring just beyond fork level; proximal to this, decumbent whitish and brown hairs combining to give appearance of 2 light and 2 dark transverse fasciae, arranged in the order, light, dark, light, dark, the last occupying the wing tip; this pattern obscure and difficult to discern except in perfect specimens; erect hairs absent on R_1, R_5, and M_4, elsewhere terminating in blackish tufts which constitute the blackish fascia; small tufts of whitish hairs at vein tips; costal and alula tufts and wing fringe of brown hairs with whitish tips, wing fringe paler near apex; hairs on veins of ventral surface of wing replaced by scales in basal ½. Legs with a covering of blackish brown scales, tibiae and

1st tarsal joints white apically; sometimes a trace of a white ring on 2nd tarsal joint.

Abdomen with sparse brown vestiture. Hypopygium with coxites (Fig. 21*F*) longer than wide, styles bent through 90° a little beyond middle. Aedeagus with a single bent point surrounded by a tent-like investment and a very long ejaculatory apodeme. Cercopods (Fig. 21*G*) short, scarcely longer than 9th tergite, not swollen basally, with a group of 10 retinaculae apically, the proximal ones longer; anal flap simple.

Female

Frontal tuft of mainly light hairs; scape with predominantly whitish scales on it; wing with no replacement of hairs by scales on ventral surface, subgenital plate rather damaged in specimens available, but apparently lacking any deep medial emargination.

Type and 2 ♀ paratypes: Townsville, 5, 6.v.1920, G. F. Hill.

Paratype: ♂ Eidsvold, 2.iv.1924, Bancroft.

I have refrained from selecting an allotype until better material of the female sex is available.

The material on which this description is based is rather fragmentary and it is clear from Tonnoir's notes and pencil sketches that he had other material by him that is no longer with the collection. It is, however, such a very distinct species that it should be described in spite of the rather poor holding.

Subgenus NOTOTELMATOSCOPUS, subgen. nov.

Eyes extended as bridges above antennae; basal flagellar segments of antennae with neck much reduced, distinctly shorter than bulb; a ring of numerous simple unbranched accessory ascoids present on the ♂ antennal segments. Wing with tip very little below R_4, radial fork a little before medial, *Sc* thick and fused to R_1, which has an unsclerotized area in it, immediately beyond this point of fusion. R_{2+3} ending at, or slightly after, apex of 1st basal cell, which is slightly longer than the 2nd. Erect hairs present on R_1, sparse or absent on R_5 and M_4.

Aedeagus bifid, caliper-like, flanked by paired rounded simple parameres. Coxites rarely longer than wide, styles curved, gently tapering, sometimes slightly angulated near the apex, a cluster of 3 or 4 small setae close to the angulation. Cercopods short, straight, little swollen basally, bearing numerous retinaculae of which the proximal are the longer and bear fringed tips. Type species *Telmatoscopus obscurus*, sp. nov.

The subgenus is remarkable for the strong development of sexual dimorphism, the females being very similar and the males showing well-developed allurement organs. All males possess some sort of allurement organ in front of the mesonotum; in addition the normal hairs are replaced by scales in various regions. This tendency reaches its extreme development in *T. dimorphus*, sp. nov., where it has involved the male wing. The venation has become so altered that even its familial position would be in doubt if the wing alone were seen.

TELMATOSCOPUS (NOTOTELMATOSCOPUS) FESTIVUS, sp. nov.

Fig. 22*A-D*

Differing from *T. gregsoni* (see Part II) only in the curiously shaped wing in the male and in slight differences in the vestiture and genitalia.

Male

Head with a moderately dense tuft of chocolate-brown hairs on face, 2 smaller tufts between antennae bases; vertex with a dense velvety pile of short chocolate-brown hairs; eye bridges separated by width of 3 facets. Antennae slightly longer than width of wing (8 : 7), scape and pedicel with a dense covering of chocolate-brown scales, flagellum with verticils rather open and greyish in colour, scape twice as long as broad, pedicel spherical, 1st flagellar segment globular with almost no neck, succeeding segments with neck better developed so that it equals the bulb in segment 6; bulb eccentric; apical segment with bulb longer than broad, bearing a club-shaped apiculus shorter than the bulb; ascoids in the form of simple hairs arranged in a ring above the hairs of the verticils on segments 3-16, 16-18 per segment. Palpi with a predominantly hairy covering; formula 1 : 1.5 : 1.5 : 2.1.

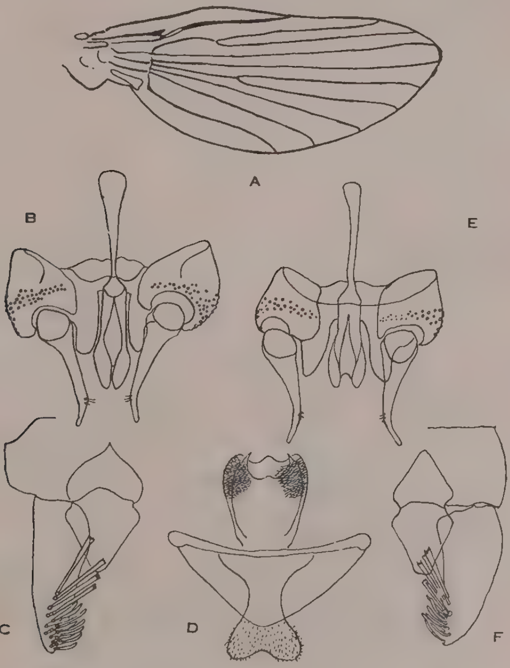

Fig. 22.—*A-D*, *Telmatoscopus festivus*, sp. nov.; *E*, *F*, *Telmatoscopus gregsoni*, sp. nov. *A*, venation; *B* and *E*, hypopygia; *C* and *F*, cercopods; *D*, subgenital plate and spermathecae.

Thorax bearing a tubular allurement organ on its anterior margin above the head; organ cylindrical, sclerotized, slightly wrinkled near the base, bearing numerous small pores on its anterior face. Vestiture consisting of an anterior median area of small, squamuliferous brownish black hairs, flanked by very conspicuous lateral plumes of long curved chocolate-brown hairs. Posterior thorax with a thinner vestiture of greyish hairs. Wing (3.1 mm long) characteristically shaped with anterior margin (Fig. 22*A*) flattened medially and then humped more proximally. *Sc* distinctly joined to R_1, which is thickened distally; wing tip between R_4 and R_5, radial fork before medial; stem of radial fork meeting R_4 at apex of 1st basal cell, which is as long as the 2nd basal cell; base of *Cu* joined to M_4. Wing covering chocolate-brown, very thick along costa, slightly darker tufts at vein tips and dark tufts over forks; erect hairs confined to bases of R_5 and M_4, reaching to a level just past tip of *Cu* on R_3, R_4, M_1, M_2, and M_3, and reaching almost to vein tips on R_1, R_2, and *Cu*; fringe unicolourous. Legs with a fringe of long hairs on tibiae, tarsi with a covering of short light brown hairs, with a silvery reflection, appearing whitish in certain lights.

Abdomen with a sparse vestiture of long greyish hairs. Hypopygium; coxites (Fig. 22*B*) swollen, style angulated near the tip, 3 small setae inserted near the angulation; length of portion distal to angulation slightly less than in *T. gregsoni* (Fig. 22*E, F*); parameres joined to coxites basally, embracing the aedeagus, which is bifid and terminates in 2 lobes like a pair of calipers; cercopods just twice as long as 9th tergite, 3 times as long as broad, with 4 long proximal retinaculae fringed at their apices and 12 or so shorter distal retinaculae (Fig. 22*C*). Anal flap triangular.

Female

Indistinguishable from that of *T. gregsoni.* No distinct tufts of darker hairs on face, scape, or pedicel; antennae a little shorter than width of wing, a single pair of simple ascoids on segments 3-16. Wing with normal shape; otherwise similar to male in venation and vestiture; tarsi more obviously white.

Subgenital plate as in Figure 22*D*, spermathecae strongly reticulate apically, ovipositor just twice as long as subgenital plate.

Type: Macquarie Pass, 23.xii.1934.

Allotype, 10 ♂, 10 ♀ paratypes: Fitzroy Falls, 22-27.xii.1937.

A ♂ and ♀ paratype are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

TELMATOSCOPUS (NOTOTELMATOSCOPUS) CRASSEPALPIS, sp. nov.

Fig. 23

As this species is represented only by 2 males and 1 female, and both the males have been dissected, the description of the vestiture can only be given for the female sex.

Related to *T. festivus* but with the maxillary palps very incrassate in the male, the wing fringe whitish at the tip, and the anterior margin of the wing not swollen.

Male

Prominent tuft of brown decumbent hair on clypeus, dark brown scaly vestiture on sides of head; eye bridges separated by width of 4 facets; antenna only slightly longer than width of wing (9 : 8), scape (Fig. 23*A*) twice as long as broad, pedicel subspherical, both heavily clothed with thick chocolate-brown scales; flagellar verticils open; basal flagellar segments almost without necks, which become more prominent distally, being best developed in medial segments but never equalling bulb; terminal segment with a very short apiculus (Fig. 23*B*), a pair of gently curved, rod-like ascoids inserted above verticils and a ring of rather more slender ascoids inserted above these in segments 3-16. Maxillary palpi (Fig. 23*A*) with segments very much thickened and heavily clothed with thick chocolate-brown scales; palpal formula 1 : 1.4 : 1.1 : 1.5.

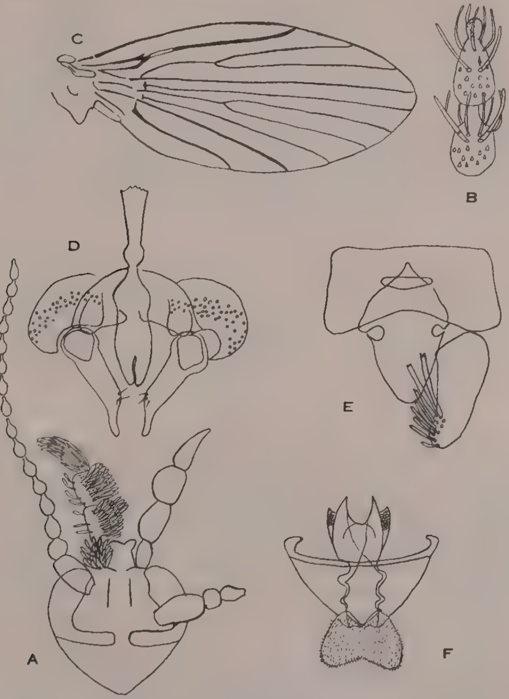

Fig. 23.—*Telmatoscopus crassepalpis*, sp. nov. *A*, head, antenna, and palp; *B*, antenna tip; *C*, venation; *D*, hypopygium; *E*, cercopod; *F*, subgenital plate.

Thorax with allurement organ in form of a small, slightly protuberant sclerotized disc with spinulose surface, situated above head below anterior lateral edge of pronotum. Wing (Fig. 23*C*) bluntly oval with apex between R_4 and R_5; *Sc* strong and fused to R_1, which is a thick vein apart from a short thin region immediately past this point of fusion; radial fork before medial, both before tip of *Cu*; stem of R_{2+3} arising just before apex of 1st basal cell, which is equal to the 2nd; *Cu* almost meeting M_4; veins very lightly sclerotized over the forks.

Hypopygium (Fig. 23*D*); coxites almost spherical, styles short and broad, angulated near the apex with scattered minute setae and a cluster of slightly larger ones at the angulation; aedeagus swollen, bifid at tip only; cercopods (Fig. 23*E*) short and stumpy, slightly longer than very short 9th tergite; 12 or so retinaculae, the proximal ones long and fringed at the tips, the distal ones short and rounded at the tip. Anal flap large, shaped like the blade of a trowel.

Female

Vestiture in general dark brown; eyes separated by width of 5 facets; prominent clypeal tuft, scantier frontal tuft between antennae; antenna a little shorter than wing width; with no accessory ascoids; palpi not incrassate.

Thorax with long brown vestiture. Wing with venation as in male; erect hairs confined to base of R_5 and M_4, present on R_1, R_2, R_3, and *Cu* to the tip, and on R_4, M_1, M_2, and M_3 to level of tip of M_4, erect hairs forming a narrow, dark, transverse fascia at level of tip of *Cu*; fringe brown with some whitish hairs around apex. Legs brown, tarsi creamy white. Subgenital plate with a shallow medial emargination; spermathecae as in Figure 23*F*, with a small area of reticulate sculpturings; ovipositor long, 2.8 times as long as subgenital plate.

Type, allotype, and 1 ♀ paratype: Pemberton, 3.xii.1936, K. R. Norris.

TELMATOSCOPUS (NOTOTELMATOSCOPUS) **OBSCURUS, sp. nov.**

Fig. 24

A dark brown species with the under surface of the wing scaly in the male.

Male

Small tuft of blackish decumbent scales on clypeus, larger tuft of blackish erect squamuliferous hairs on frons, extending between eye bridges; eye bridges separated by width of 4 facets. Antenna rather less than twice width of wing (13 : 8), scape and pedicel covered with blackish scales, flagellum light brown with open verticils; scape 1½ times as long as wide (Fig. 24*A*), pedicel a little longer than wide, basal flagellar segment fusiform, succeeding ones gradually acquiring a neck which is always shorter than the bulb (Fig. 24*B*). Ascoids simple, numerous, arranged in a ring, varying from 22 in the 2nd flagellar segment to 12 in the terminal one, where they are rather more scattered. Palpi (Fig. 24*C*) with a mainly hairy covering; palpal formula 1 : 1.9 : 1.8 : 2.9.

Thorax with an anterior median patch of short brownish black scales, bordered on either side by long, erect, brown hairs; vestiture elsewhere consisting of rather sparse greyish brown hair. An allurement organ shaped as in Figure 24*D* present on thorax immediately above head, on membranous part of thoracic well. Wing 2.3 mm long (Fig. 24*E*), ovate with apex immediately below tip of R_4; R_1 thick, unsclerotized immediately after fusion with *Sc*; radial fork very slightly before medial, both approximately midway between apices of basal cells and tip of *Cu*; basal cells subequal, *Cu* nearly joined to M_4; erect hairs present on bases only of R_5 and M_4, extending almost to tips of R_1, R_2, R_3, and *Cu*, a little before this level on R_4 and to level of tip of *Cu* on M_1, M_2, and M_3; fringe brownish apart from a few whitish hairs around wing apex; ventral surface of wing appearing darker owing to even rows of blackish brown scales distributed along course of all veins in basal 2/3 of wing. Legs brown with tibiae fringed with long hair; tarsi uniformly creamy white.

Abdomen with erect brown hairs. Hypopygium (Fig. 24*F*); coxite as long as wide, style angulated just beyond middle, bearing a cluster of 4 small setae at the angulation; parameres embracing aedeagus, which is bifid and terminates in 2 pointed blades; cercopods short (Fig. 24*G*), scarcely twice as long as 9th tergite, bearing 6 or so long proximal retinaculae with fringed tips, and 12-14 shorter distal retinaculae; anal flap triangular.

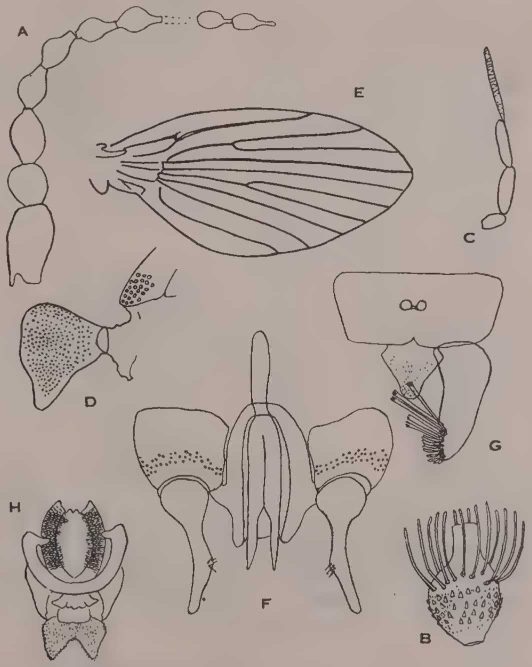

Fig. 24.—*Telmatoscopus obscurus*, sp. nov. *A*, antenna; *B*, medial antennal segment; *C*, palp; *D*, allurement organ; *E*, venation; *F*, hypopygium; *G*, cercopod; *H*, subgenital plate and spermathecae.

Female

Tufts on clypeus and frons and scales on scape and pedicel, light brown; antenna with only 2 ascoids on segments 3-16; thorax without the median anterior patch of scales; wing without dark scales on basal 2/3 of lower surface; tarsi with a pale reflection but not obviously creamy white; subgenital plate as in Figure 24*H*, spermathecae strongly reticulate.

Type: National Park, Queensland, Jan. 1928, A. J. Nicholson. Allotype, 3 ♂, 1 ♀ paratypes: Narara, 3.ii.1921. 2 ♀ paratypes, Mt. Wilson, 19.ii.1921.

A ♂ and ♀ paratype are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

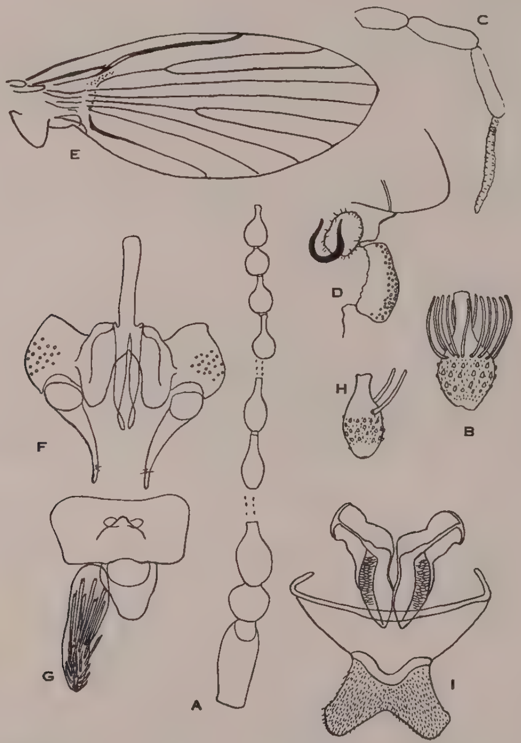

Fig. 25.—*Telmatoscopus nicholsoni*, sp. nov. *A*, antenna; *B*, medial antennal segment; *C*, palp; *D*, allurement organ; *E*, venation; *F*, hypopygium; *G*, cercopod; *H*, antennal segment of ♀; *I*, subgenital plate and spermathecae.

Telmatoscopus (Nototelmatoscopus) nicholsoni, sp. nov.

Fig. 25

In the manuscript notes on this species the name *T. fuscus* is suggested. As Tonnoir has already used this name for one of his African species of this genus (which is certainly very different from the one about to be described) I am renaming it. In calling it *T. nicholsoni* I am dedicating it to Dr. A. J. Nicholson, Chief of the Division of Entomology, C.S.I.R.O., Australia, whose kindness in lending me their collections of Psychodidae I should like to acknowledge.

A dark brown species belonging to the *obscurus-crassepalpis* group but with unicolourous legs and characteristic ♀ genitalia.

Male

Dense tuft of dark decumbent hairs on clypeus and of erect hairs on frons; short, dark, erect hairs covering whole of epicranium; eye bridges 4 facets wide, separated by width of 3 facets. Antennae 1.6 times as long as width of wing; scape and pedicel with a covering of blackish scales and hairs; flagellum greyish brown; scape a little more than twice as long as broad; pedicel subspherical (Fig. 25*A*), basal flagellar segment with almost no neck, medial ones (Fig. 25*B*) with a neck almost as long as the bulb, terminal ones (Fig. 25*A*) with shorter necks again, the last bearing an apiculus shorter than the bulb, ascoids numerous and simple, forming verticils on segments 3-16 (Fig. 25*B*). Palpi with a thick covering of dark scales, palpal formula 1 : 1.8 : 1.7 : 2.1 (Fig. 25*C*).

Thorax with a dense covering of dark erect hairs; an allurement organ present under anterior corner of pronotum, immediately in front of spiracle (Fig. 25*D*). Wing 2.8 mm long (Fig. 25*E*); broadly oval with the apex just below R_4, radial fork well before medial, both before level of tip of *Cu*; R_{2+3} joining R_4 at apex of 1st basal cell, which is equal to the 2nd, R_1 thickly sclerotized, apart from a clear area immediately after the junction with *Sc*. Wing vestiture dark; blackish tufts of erect hairs over forks and tip of *Cu*; erect hairs present on bases only of R_5 and M_4; extending to the tip of R_1, R_2, R_3, and *Cu*, and to the level of an imaginary line joining the tip of R_2 and *Cu* on M_1, M_2, and M_3. Legs uniformly brown.

Abdomen with hairy vestiture. Hypopygium (Fig. 25*F*) very similar to that of *T. festivus* and *T. gregsoni*, with a caliper-like aedeagus, simple lobular parameres, and gently curving styles; cercopods (Fig. 25*G*) with 25 or so retinaculae; proximal ones long and fringed at tips. Anal flap rounded in outline.

Female

Similar to male but antennae shorter, even the medial segments (Fig. 25*H*) having very reduced necks; only the paired ascoids present. Subgenital plate (Fig. 25*I*) with long diverging flaps, in life wrapping round base of ovipositor.* Spermathecae with reticulate capsules and diverging stiffening rods with anchor-like ends. Ovipositor 1.7 times as long as subgenital plate.

Type, 2 ♂ paratypes: National Park, Tasmania, 15.xii.1922.

Allotype: Mt. Wellington, 2.xii.1922.

Paratypes: 2 ♀, Burnie, 24-27.x.1922, and 31.i.1933. 4 ♂, same locality, 21.x.1933. 3 ♂, Eaglehawk Neck, 17-22, 23.xi.1922.

Other specimens: 3 ♂ damaged, National Park, Tasmania, 15.xii.1922. 1 ♂, Burnie, 27.x.1922. 1 ♂, Geeveston, 7.xii.1922.

Three ♂ paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

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* The precise shape that the subgenital plate will appear to have depends upon the degree of flattening of the preparation. Figure 25*I* shows a fully flattened preparation, but in a less compressed mount the tips of the distal lobes would appear rounded rather than squarish.

Subgenus EUTELMATOSCOPUS, subgen. nov.

Eyes extended as bridges above antennae. Basal flagellar segments of antenna with neck approximately equal to bulb; ascoids simple, paired, and inserted close together on the swollen portion of the asymmetrical bulb. No allurement organ on thorax above head.

Wing with apex immediately above R_5, radial fork usually beyond medial; Sc thin and ending freely, 1st basal cell longer than 2nd. Erect hairs absent from R_1, R_5, and M_4.

Aedeagus shovel or scoop-like, never flanked by lateral parameres. Coxite considerably longer than wide; style a simple tapering curved blade. Cercopods long, gently tapering, curved inwards and terminating in 1 or more, but never many, simple retinaculae. Type species *T. spiralifer,* sp. nov. (Part II).

This subgenus includes, besides *T. spiralifer,* Tonnoir's species *T. aberrans,* and the new species *T. norrisi, T. confusus, T. fordi,* and *T. neglectus.* In general the males of this subgenus do not show the specialized sexual ornamentation so characteristic of the subgenus *Nototelmatoscopus.* The feature most readily distinguishing both sexes of the 2 subgenera, however, is the absence of erect hairs of R_1 in *Eutelmatoscopus* and their presence in *Nototelmatoscopus.*

Telmatoscopus (Eutelmatoscopus) neglectus, sp. nov.

Fig. 26

A small, uniformly ochraceous species.

Male

Ochraceous tuft on clypeus, sparse erect hairs on vertex; eye bridges separated by width of 1 facet, antennae almost twice as long as width of wing (12 : 7.5) verticils open; scape 1¼ times as long as wide, pedicel spherical, 1st flagellar segment with neck equal to bulb; longer than bulb in succeeding segments, bulb markedly eccentric (Fig. 26*A*); ascoids paired, simple, much curved, on segments 3-16; terminal segment ending in an apiculus a little longer than bulb. Palpal formula 1 : 1.7 : 1.6 : 2.5 (Fig. 26*B*).

Thorax with even covering of erect ochraceous hairs slightly darker at the tips; no allurement organ present, wing 2.3 mm long, ovolanceolate (Fig. 26*C*), apex just above tip of R_5, Sc not joined to R_1 distally, radial fork after medial, immediately above tip of Cu; origin of R_{2+3} a little before apex of 1st basal cell, which is distinctly longer than 2nd basal cell; Cu not joined to M_4 basally. Wing vestiture and fringe uniformly ochraceous. Erect hairs absent on R_1, R_5, and M_4, present to tip on R_2 and Cu, and up to level of tip of R_2 on R_3 and R_4 to level of tip of Cu on M_2 and M_3. Legs ochraceous, tarsi with a white gloss dorsally.

Hypopygium; coxite (Fig. 26*D*) almost twice as long as wide; styles little curved, gently tapering, notched subapically on their inner sides, devoid of prominent sensory setae; aedeagus rounded with a stiffening rod shaped like an inverted T, with 2 small triangular plates attached to the arms; cercopod (Fig. 26*E*) strongly curved, slightly longer than 9th tergite, scarcely swollen basally, not tapered, bearing an apical cluster of 5-7 short retinaculae; anal flap of characteristic shape.

Female

Antennal segments not eccentric (Fig. 26*G*), ascoids short and not markedly curved, on segments 4-15 only. Subgenital plate consisting of paired lobes of characteristic shape (Fig. 26*E*). Spermathecae bearing a prominent rod-like thickening and some medial reticulation; ovipositor scarcely twice as long as subgenital plate.

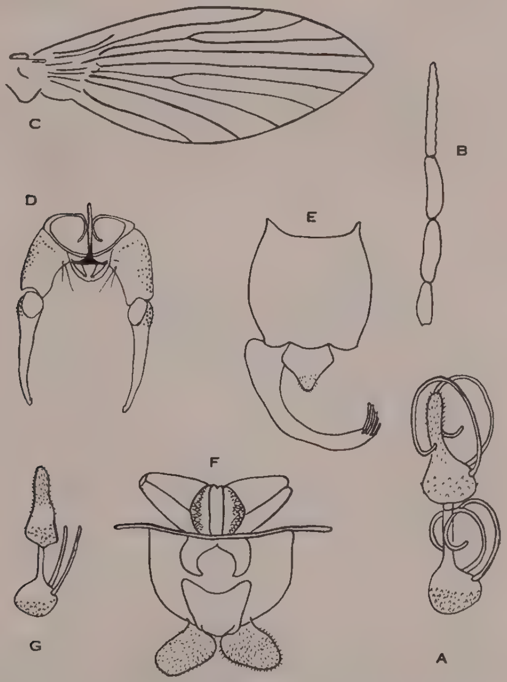

Fig. 26.—*Telmatoscopus neglectus*, sp. nov. *A*, tip of antenna; *B*, palp; *C*, venation; *D*, hypopygium; *E*, cercopods; *F*, subgenital plate and spermathecae; *G*, tip of ♀ antenna.

Type: Kangaroo Valley, 11.ii.1933.

Allotype: Jenolan Caves, Feb. 1937.

Paratypes: 5 ♂, Mt. Wilson, 19.xi.1921. 1 ♂, Wentworth Falls, 18.xi.1921. 1 ♂, Kangaroo Valley, 11.ii.1923. 1 ♀, Kangaroo Valley, 11.ii.1933.

Other specimens: 2 ♂, Mt. Wilson, 19.xi.1921. 3 ♂, Mt. Kembla, 12.ii.1933. 1 ♂ with type.

Tonnoir had only included 3 specimens, the type, allotype, and female paratype, under this species, the remaining specimens lying in other positions in the collection, and 1 of them bearing the label *T. elongatus*—presumably the type of another species. In all these male specimens other than the type, the genitalia are rather more elongate and the retinaculae differ in length amongst themselves more noticeably. However, these differences appear to intergrade and I am placing the specimens under the *neglecta* label. Additional material may, however, prove that 2 closely related though distinct species are involved.

TELMATOSCOPUS (EUTELMATOSCOPUS) NORRISI, sp. nov.

Fig. 27

A pale ochraceous species with a pale fuscous fascia across the wing, and the wing tip infuscated.

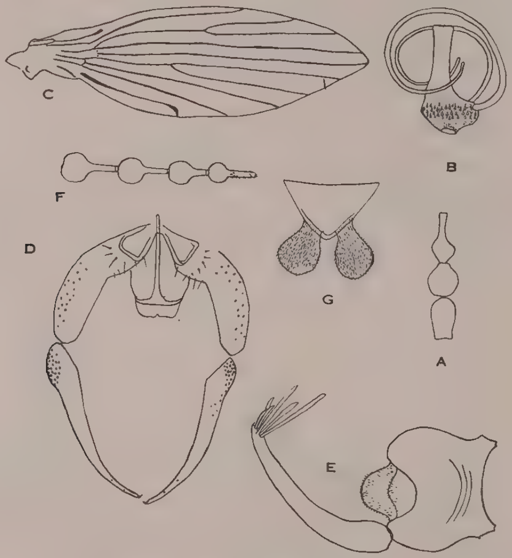

Fig. 27.—*Telmatoscopus norrisi*, sp. nov. *A*, base of antenna; *B*, medial antennal segment; *C*, venation; *D*, hypopygium; *E*, cercopod; *F*, antenna tip of ♀; *G*, subgenital plate.

Male

Clypeal tuft decumbent, frontal tuft erect, both pale fuscous; eye bridges 4 facets wide, separated by width of 1 facet; vertex with a covering of whitish hairs. Antennae 2½ times as long as width of wing; pedicel, scape, and base of 1st flagellar segment with a pale fuscous scaly covering; remainder of flagellum brownish grey with almost closed verticils; pedicel twice as long as broad (Fig. 27*A*), basal flagellar segment with neck a little longer than bulb; subsequent segments with necks considerably longer than bulbs, which are markedly eccentric (Fig. 27*B*); ascoids paired, simple, very long, and curved in an almost complete circle. Palpi with ochraceous scaly covering; palpal formula not investigated.

Thorax with vestiture largely removed but apparently ochraceous; no allurement organ present. Wing (Fig. 27*C*) lanceolate, 2.2 mm long, apex just above tip of R_5; *Sc* not joined to R_1 distally; medial fork above tip of *Cu*, well before radial; 1st basal cell longer than 2nd; *Cu* not joined to M_4 basally. Wing membrane infuscated in a broad transverse fascia running across the forks to the base of *Cu*, and in the apical portion from a line joining the tip of R_2 to M_2; vestiture also infuscated over these areas and fuscous tufts occurring at the tip of each vein; remainder of wing vestiture pale ochraceous; distribution of erect hairs too damaged to be described. Legs pale fuscous with lighter rings at apices of tibae and 1st 2 tarsal joints.

Abdomen with vestiture largely absent. Hypopygium (Fig. 27*D*) with coxite almost 3 times as long as wide; style long and gently curved, devoid of prominent sensory setae. Aedeagus scoop-like with a stiffening rod shaped like an inverted T. Cercopod gently curved and tapering (Fig. 27*E*) a little swollen at base, longer than 9th tergite, bearing a cluster of 6 or so retinaculae at the tip; anal flap with rounded outline.

Female

Similar to male but antennal segments not markedly eccentric (Fig. 27*F*) and ascoids not prominently curved. Subgenital plate with widely separated, slightly squarish lobes (Fig. 27*G*); spermathecae in allotype and only female not well displayed. Ovipositor more than 3 times as long as subgenital plate.

Type, allotype, and 4 ♂ paratypes: Pemberton, 2.xii.1933, K. R. Norris.

One of the ♂ paratypes is in the Division of Entomology Museum, C.S.I.R.O., Canberra.

The species name, originally suggested by Tonnoir, dedicates the species to Mr. K. R. Norris, who collected not only the material on which the description is based, but also other specimens of Psychodidae in the collection.

TELMATOSCOPUS (EUTELMATOSCOPUS) CONFUSUS, sp. nov.

Fig. 28

A uniformly dark brown species with darker tufts over the forks and indistinct darker tufts at the vein tips.

Male

Clypeal tuft decumbent, frontal tuft erect; vertex covered with erect hairs, eye bridges 4 facets wide, separated by width of 1 facet; antennae uniformly brown, twice as long as wing width, verticils almost closed; scape ½ as long again as broad (Fig. 28*A*), pedicel subspherical, basal flagellar segment with neck equal to bulb, which is eccentric, longer than bulb in medial segments; bulbs moderately asymmetrical, terminal segment (Fig. 28*B*) with an apiculus longer than bulb; ascoids simple, much curved, with their bases close together, inserted on segments 3-15. Palpi with a covering of light brown scales (Fig. 28*C*), palpal formula 1 : 1.6 : 1.7 : 2.5.

Thorax with bronzy vestiture of long hairs; medial and lateral rows of short whitish hairs interspersed; no allurement organ present. Wing ovolanceolate (Fig. 28*D*) 2.3 mm long, with apex just above tip of R_5; *Sc* not joined to R_1 distally, radial fork after medial fork, which is before tip of *Cu*, R_{2+3} joining

R_4 after apex of 1st basal cell, which is a little longer than 2nd; *Cu* not joined to M_4 basally. Wing vestiture brown apart from distinctly darker brown tufts over forks and slightly darker tufts at vein tips, erect hairs absent on R_1, R_5, and M_4, reaching farthest along R_3 and R_4 where they extend to level of tip of R_1, to just short of this level on M_1, M_2, and M_3, and to the tip of *Cu*. Legs uniformly brown.

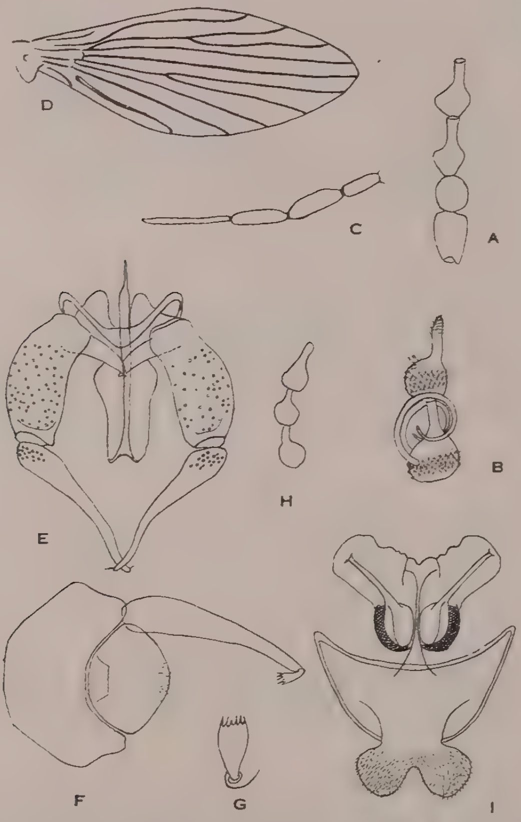

Fig. 28.—*Telmatoscopus confusus*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, palp; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, retinaculum; *H*, ♀ antennal tip; *I*, subgenital plate and spermathecae.

Abdomen with long, brown vestiture. Hypopygium with coxite (Fig. 28*E*) more than twice as long as broad, styles long, thin, gently tapering, and slightly curved; a single small sensory seta at apex, otherwise devoid of special sensory setae. Aedeagus bifid, scoop-shaped; 9th sternite broader medially. Cercopods (Fig. 28*F*) slender and tapering, longer than 9th tergite, bearing a single retinaculum with a toothed margin (Fig. 28*G*); anal flap broadly oval, wider than long.

Female

Eye bridges separated by width of 2 facets; antenna only slightly longer than width of wing, segments with necks equal to, or shorter than, bulb (Fig. 28*H*), apiculus shorter than bulb. Subgenital plate with rounded lobes, diverging at right angles (Fig. 28*I*); subgenital plate with a covering of light brown scales; spermathecae of characteristic shape bearing a central area of reticulation (Fig. 28*I*). Ovipositor twice as long as subgenital plate.

Type, allotype, and 3 ♂, 3 ♀ paratypes: Eaglehawk Neck, 15-22.xi.1922.

Paratype: 2 ♂, 5 ♀, Fitzroy Falls, 22-27.xi.1937. 1 ♂, National Park, Tasmania, 17.xii.1922. 1 ♂, 3 ♀, Shannon Creek, 20.xi.1939. 1 ♀, Advent Bay, 30.xii.1922.

Other specimens: 2 ♂, Blundells, 13.xi.1938.

One of the paratypes and the 2 other specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

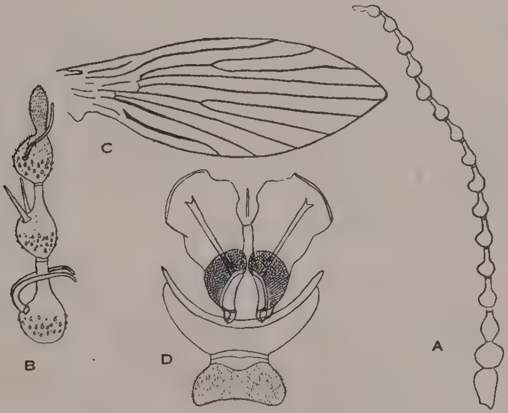

Fig. 29.—*Telmatoscopus fordi,* sp. nov. *A,* antenna; *B,* antennal tip; *C,* venation; *D,* subgenital plate and spermathecae.

TELMATOSCOPUS (EUTELMATOSCOPUS) FORDI, sp. nov.

Fig. 29

This species, so far known only from the ♀ sex, is represented by 15 specimens originally placed in Tonnoir's *T. spiralifer* row. A perusal of the appropriate manuscript notes makes it clear that Tonnoir realized that more than one species was included under the *T. spiralifer* label, though his death occurred before the assemblage had been sorted out. I have left the original temporary labels on the specimens, but have selected a type and paratypes.

A predominantly fuscous species distinguished by the subgenital plate in the female.

Female

Tuft of fuscous hairs on frons; vertex with scattered hairs; eye bridges separated by width of 3 facets. Antennae (Fig. 29*A*) slightly longer than width of wing (6 : 5), scape and pedicel with whitish scales, flagellum brown with greyish reflection; scape 1¼ times as long as broad, pedicel subspherical, 1st flagellar segment with very little neck; succeeding segments with longer necks and eccentric bulbs, terminal segment (Fig. 29*B*) with a rather fat apiculus equal to the bulb; ascoids paired, curved, on segments 4-16, those on 15 and 16 being somewhat reduced. Palpi with 1st segment short, 2nd and 3rd subequal, larger than 1st, 4th larger still; covered with fuscous scales with a whitish reflection.

Thorax with vestiture of long, erect, fuscous hairs, with short, paler scales interspersed; wing (Fig. 29*C*) ovolanceolate, pointed; 2.3 mm long; apex just above tip of R_5, Sc not joined to R_1 distally; radial fork a little after medial but before tip of Cu; stem of R_{2+3} arising just before apex of 1st basal cell, which is considerably longer than 2nd basal cell; Cu not joined to M_4 basally. Wing vestiture and fringe uniformly fuscous; erect hairs absent from R_1, R_5, and M_4; extending along R_2, R_3, and Cu to just short of the tip, along R_4 and M_1 to same level as on R_3, and along M_2 and M_3 to level of tip of M_4. Legs unicolourous, covered with fuscous scales with a silvery reflection.

Abdomen with scattered tufts of fuscous hairs; subgenital plate transverse (Fig. 29*D*) with very little medial emargination; spermathecae elaborate, with a longitudinal ridge and an extensive medial patch of reticulation. Ovipositor a little more than twice as long as subgenital plate (11 : 5).

Type: ♀, Wentworth Falls, 18.ii.1921.

Paratypes: 5 ♀, Fitzroy Falls, 22-27.ii.1937. 1 ♀, Mt. Wilson, 19.ii.1921. 1 ♀, Mt. Kembla, 12.ii.1933. 1 ♀, Kangaroo Valley, 11.ii.1933.

Other specimens: 2 ♀, Fitzroy Falls, 22-27.xi.1937. 3 ♀, Brown Mt., 25.ii.1939. 1 ♀, Waterfall, Nov. 1921.

One ♀ paratype is in the Division of Entomology Museum, C.S.I.R.O., Canberra.

In naming the species as above, I am dedicating it to Professor Edward Ford, Director of the School of Public Health and Tropical Medicine, Sydney, whose kindness and cooperation in lending me the Tonnoir collection of Australian Psychodidae I should like to acknowledge.

Genus BRUNETTIA Annandale

Brunettia Annandale, 1910, *Rec. Indian. Mus.* 5: 141-4.

There is a manuscript description of a female specimen of a species of *Brunettia* from Tasmania, but no specimens exist in the collection and no description can be given.

Freeman (1951) has pointed out that the genera *Pericoma, Brunettia*, and *Telmatoscopus* form an intergrading series but that we are not justified in abandoning them on this account because the bulk of the species fall fairly readily into one or other of these 3 genera. He drew up a new generic diagnosis for

Brunettia, which has been broadened to include more recently described species including two, *B. unipunctata* and *B. infurcata,* described later in his paper. Prior to this, almost the only feature that could be relied on to separate *Brunettia* from *Telmatoscopus* was the presence of hairs or scales on the wing membrane as well as on the veins. In *Brunettia infurcata* Freeman, even this feature is less definite, since the scales are restricted to the anal and humeral areas.

In the Tonnoir collection are 2 species of Psychodidae with 15-segmented antennae in which the segments have well-developed necks and eccentric basal bulbs bearing a single pair of curved ascoids. The wing has a strongly pectinate radial sector and the male and female genitalia are exceedingly similar to those of *Brunettia albonotata* Brun. (= *B. indica* Eaton), *B. biformis* Edwards, and *B. novae-zealandica* Satchell. They show the same racket-shaped retinaculae, the simple angulated styles with a pair of small setae at the angle, and the symmetrical aedeagus bearing lateral facets articulating with facets on the parameres. The shape of the subgenital plate and spermathecae in the female are very similar, but the wing membrane is entirely devoid of hairs. A comparison of these 2 species with *B. albonotata* or *B. novae-zealandica* gives a firm impression that here we are dealing with a related form with hairless wing membrane. On the other hand, there is no formal reason why the species should not be put into the genus *Telmatoscopus* since a number of Palaearctic species of *Telmatoscopus* have 15-segmented antennae. To do so, however, would mask the very strong resemblances between the genitalia of these 2 species and those of *Brunettia,* and I propose therefore to erect a new genus, *Atrichobrunettia,* to house those members of the *Brunettia-Telmatoscopus* complex in which the retinaculae are racket-shaped but the wing membrane is devoid of hairs.

Genus ATRICHOBRUNETTIA, gen. nov.

Antennae 15-segmented, the flagellar segments consisting of an asymmetrical basal bulb and a distal neck; ascoids paired, simple, curved rods inserted close together on the basal bulb. Segment 15 with an apiculus. Wing with R_1, R_5, and M_4 thickened, *Rs* pectinate, hairs on the veins, but not on the wing membrane. Male hypopygium with styles angulated subapically and 2 rather prominent sensory hairs inserted near the angulation. Both coxite and style devoid of their usual prominent lateral tufts of hairs, the coxite being quite naked. Aedeagus bifid, symmetrical, articulating by lateral facets with facets on the parameres. Cercopods with characteristic retinaculae of the "racket" type, consisting of a disc-like portion fringed with a series of apposed lamellae. Female with a subgenital plate in which the pilose lobes are not united across the mid line; the spermathecae of a characteristic shape. Type species: *Atrichobrunettia alternata,* sp. nov.

Atrichobrunettia alternata, sp. nov.

Fig. 30

A moderate-sized species with alternate patches of dark brown and cream in the wing fringe.

Male

Clypeal tuft of dark brown decumbent hairs; frontal tuft of brown erect hairs; extending between antennae bases; eye bridges touching. Antenna 15-segmented, almost twice as long as width of wing (7 : 13); verticils light brown with a silvery reflection; scape and pedicel covered with light brown to silvery scales admixed with hairs. Scape (Fig. 30*A*) twice as long as broad; pedicel subspherical; basal flagellar segments amphora-shaped with neck shorter than bulb; succeeding segments slightly asymmetrical with neck lengthening until it is distinctly longer than bulb in median segments; subapical segment (Fig. 30*B*), with neck shorter than bulb, apical segments with an apiculus shorter than bulb, which has a long and a short sensory rod on one side; ascoids simple, very long, thin, curved, borne on a slight bulge with their bases close together, on segments 3-14. Palpi with a sparse covering of silvery white scales; palpal formula 1 : 2.7 : 2.4 : 3.1 (Fig. 30*C*).

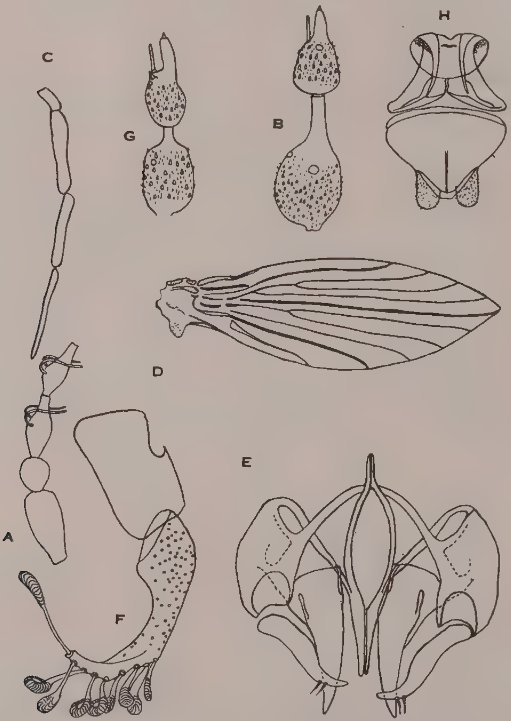

Fig. 30.—*Atrichobrunettia alternata*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, palp; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, tip of ♀ antenna; *H*, subgenital plate and spermathecae.

Thorax with a dense reddish brown vestiture, darker between the wing bases and paler at the sides; no allurement organ present but anepisternite rather protuberant and bearing a tuft of brown erect hairs. Wing 2.5 mm long, very elongate (Fig. 30*D*), apex above tip of R_5, radial fork a little after medial fork, radial sector markedly pectinate, R_4 arising from R_{2+3} well after apex of 1st basal cell, which is longer than 2nd; R_1, R_5, and M_4 thicker and more strongly sclerotized than other veins; Cu a very broad and diffuse vein, costal tuft and alula tuft reddish brown; erect hairs absent on R_5 and M_4, present on remaining veins up to a line joining tip of Cu with a point just short of tip of R_1; patch of erect hairs consisting of a medial area of sienna-brown hairs with a bronzy reflection, bordered by white hairs both proximally and distally; a transverse fascia of decumbent sienna-brown hairs distal to patch of erect hairs; remainder of wing vane covered with less dense decumbent sienna-brown hairs. Wing fringe marked with alternate patches of sienna-brown and creamy hairs; 11 sienna-brown patches in all, 1 behind each vein tip except R_5, on anterior margin, and behind each vein tip, including R_5 on posterior margin; that behind Cu very small and inconspicuous. Legs with black vestiture; rings of scales with a silvery white reflection at tip of tibiae and 1st 2 tarsal joints.

Vestiture of abdomen less reddish than thorax. Hypopygium (Fig. 30*E*); coxites longer than wide, lacking any hairy covering, styles short, angulated near tip, bearing 2 prominent sensory setae inserted close together at point of angulation; lacking any lateral tuft of setae at base; aedeagus symmetrical, bifid, with lateral facets articulating with the triangular parameres. Cercopods (Fig. 30*F*), longer than 9th tergite, uniformly covered with long hair, bearing 9 or so retinaculae of the type characteristic of the genus; retinaculae not angulated.

Female

Similar to male but antenna shorter with preapical neck considerably shorter than bulb (Fig. 30*G*). Subgenital plate and spermathecae characteristic of genus (Fig. 30*H*). Ovipositor 2.2 times as long as subgenital plate.

Type: National Park, Tasmania, 11.xii.1922.

Allotype: Sassafras, 19.x.1922.

Paratypes: Cradle Valley, 1 ♂, 12.i.1923. 1 ♂, 16.i.1923. 1 ♂, Harz Mt., 9.xii.1922. 1 ♂, Mt. Field, 21.xii.1922. 1 ♂, 1 ♀, Brown Mt., 25.ii.1939. 1 ♂, St. Patrick's River, 1.xi.1922. 1 ♂, Mittagong, Sept. 1936, Miss M. Fuller. Bred from mud. 2 ♂, Mt. Wilson, 19.xi.1921. 1 ♂, National Park, Tasmania, 15.xii.1922. 1 ♀, 17.xii.1922. 1 ♂, Mt. Wellington, 2.xii.1922. 1 ♀, Strahan, 6.ii.1922. 2 ♂, 1 ♀, Burnie, 22.x.1933. 1 ♀, Eaglehawk Neck, 20.xi.1922. 2 ♀, Sassafras, 21.x.1922. 1 ♀, Ferntree Gully, 25.x.1921. 1 ♀, Blundells, 10.x.1930.

Other specimens: 1 ♂, 1 ♀, St. Patrick's River, 1.xi.1922. 2 ♂, Mt. Wilson, 19.xi.1921. Mt. Wellington, 1 ♂, 25.xi.1921. 2 ♂, 1.xii.1921, 2 ♀, 2.xii.1921. Sassafras, 1 ♂, 10.xi.1922, 1 ♂, 19.xi.1921. 1 ♂, Geeveston, 8.xii.1922. Ferntree, 1 ♂, 12.xi.1922, 1 ♂, 25.xi.1921. 1 ♂, Harz Mt., 19.xii.1922. 1 ♀, Eaglehawk Neck, 22.xi.1922. 1 ♀, Strahan, 6.ii.1923. 2 ♀, National Park, Tasmania, 17.xii.1922. 1 ♀, Advent Bay, 30.xii.1922.

Five of the paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

Some specimens from Cradle Valley are rather paler in colour and Tonnoir has separated them out as a separate variety in his manuscript notes. However, species that are well known, such as *Psychoda alternata* Say, can vary very greatly in the general hue of their vestiture and I think it is inadvisable to create separate varieties on a mere difference in colour intensity. The specimens have therefore all been included under the one label.

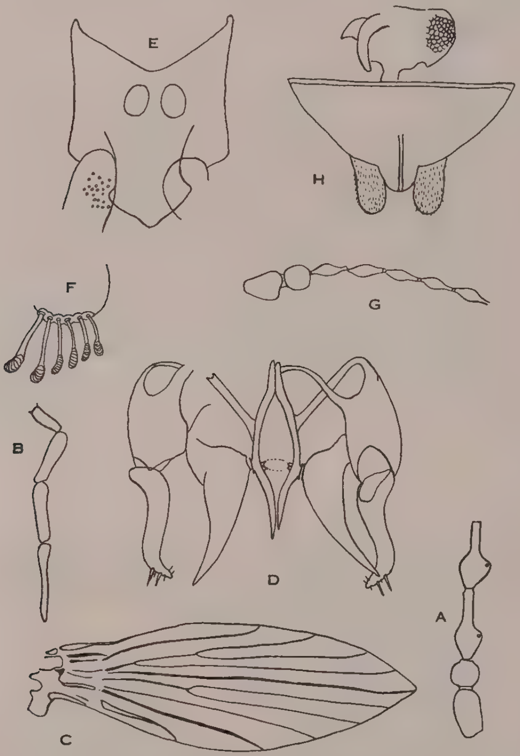

Fig. 31.—*Atrichobrunettia subalternata*, sp. nov. *A*, antenna base; *B*, palp; *C*, venation; *D*, hypopygium; *E*, 9th tergite; *F*, tip of cercopod; *G*, base of ♀ antenna; *H*, subgenital plate.

ATRICHOBRUNETTIA SUBALTERNATA, sp. nov.

Fig. 31

Closely related to *A. alternata*, from which it differs mainly in minor details of the genitalia and wing venation. The 2 specimens on which this species is based have both been dissected so no reference to the vestiture can be made apart from a few details about the male wing and legs, which have been mounted whole.

Male

Eye bridges separated by width of 2 facets. Antenna with scape (Fig. 31*A*) scarcely twice as long as broad, pedicel subspherical; basal flagellar segment with neck longer than bulb, which is markedly eccentric; palpal formula 1 : 3.2 : 2.8 : 3.5 (Fig. 31*B*).

Wing (Fig. 31*C*) 1.5 mm long, venation very similar to that of *A. alternata*, differing in closer proximity of wing apex to tip of R_5, and in origin of R_{2+3} meeting R_4 nearer its base so that the distance between the bifurcation of R_{2+3} and R_4 and the bifurcation of R_2 and R_3 is greater than the stem of R_{2+3+4} in *A. subalternata* and almost equal to it in *A. alternata*. Vestiture of wing largely missing in type but wing fringe with apparently the same arrangement of alternating light and dark patches as in *A. alternata*. Legs as in *A. alternata*.

Hypopygium (Fig. 31*D*); coxite and style similar to those of *A. alternata* but 4 or so small sensory setae occurring close to the 2 large setae. Aedeagus bifid and with one ½ slightly shorter than the other, articulating with the parameres. Cercopods broken in type but apparently with only 6 racket-shaped retinaculae (Fig. 31*E-F*).

Female

Eye bridges separated by width of 6 facets. Antenna (Fig. 31*G*) with scape only a little longer than wide, basal flagellar segments almost fusiform, with little distinction between neck and bulb; succeeding ones more flask-shaped. Subgenital plate (Fig. 31*H*) rather wider and shallower than in *A. alternata*; spermathecae damaged and contorted in allotype but with a strongly reticulate pattern of sculpturings on them. Ovipositor 2.4 times as long as subgenital plate.

Type and allotype: Pemberton, 2.xii.1936, K. R. Norris. ♀ Paratype, Fitzroy Falls, 22-27.xi.1937.

Genus NEMONEURA Tonnoir

Nemoneura Tonnoir, 1929, Dipt. Patagonia and S. Chile 2 (1): 27.

In 1929 Tonnoir described a new genus of Psychodinae, *Nemoneura*, characterized by the elongate subcosta. He remarks (p. 3) "The new genus *Nemoneura* created here to receive two Chilean species, has a very close ally, equally new, in New Zealand, represented by a single species."

In the Australian collection is a single specimen of a female psychodine fly with an elongate subcosta, allied to, if not cogeneric with, *Nemoneura*. It lacks a locality label, and I am thus at a loss to know whether this is the New Zealand species mentioned by Tonnoir, somehow placed in the wrong box, or whether it really is Australian. I incline to the former view as there is another, quite clearly New Zealand specimen, with a Nelson label on it, in the Australian collection. Moreover, there is absolutely no mention of this extremely interesting species anywhere in the notes on the Australian material, and I was unable to find the species amongst the New Zealand material when working over it 3 years ago. I am not therefore describing it on this occasion, and have not included it in the key. Should it turn out to be present in Australia, it would come out in the key at couplet 5 with *Notiocharis* and *Pericoma*, but would be immediately separable from these by the elongate subcosta.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge my indebtedness to Mrs. A. L. Tonnoir for permission to publish her husband's manuscript work, to Professor E. Ford of the Sydney School of Public Health and Tropical Medicine, and to Dr. A. J. Nicholson, Chief of the Division of Entomology, C.S.I.R.O., for their loan of the Tonnoir collection of Australian Psychodidae and the accompanying manuscript notes. Thanks are also due to Mr. R. F. Riek of Brisbane for some light-trap material, and to Professor B. J. Marples of Otago University for discussion in the course of this work.

THE AUSTRALIAN PSYCHODIDAE (DIPTERA), PART II

By the Late A. L. Tonnoir

[*Manuscript received September* 4, 1952]

Summary

The following new species are described: *Pericoma uniformata,* sp. nov., *P. punctulata,* sp. nov., *P. illustrata,* sp. nov., *P. subillustrata,* sp. nov., *P. tasmaniae,* sp. nov., *P. albipes,* sp. nov., *P. rotundipennis,* sp. nov., *P. intricatoria,* sp. nov., *Telmatoscopus* (*Nototelmatoscopus*) *gregsoni,* sp. nov., *T.* (*N.*) *dimorphus,* sp. nov., *T.* (*N.*) *viduatus,* sp. nov., *T.* (*Eutelmatoscopus*) *aberrans,* sp. nov., and *T.* (*E.*) *spiralifer,* sp. nov.

The species *Telmatoscopus townsvillensis* Taylor is redescribed.

Pericoma uniformata, sp. nov.

Fig. 32

Species with uniform ochraceous brown covering on body, legs, and wings, which do not exhibit any darker tufts or markings; the 2 forks near the base of the wing and placed about at the same level; apex of wing just a little above tip of R_5. Length of wing 2.8 mm.

Male

The covering of the body and all the appendages is of a uniform colour, light ochraceous brown, such as is found in common species of *Psychoda* of the *severini* group, so that this species may be confused, at first sight, with a species of that genus, were it not for the conformation of the antennae. Eye bridges 3 facets wide and nearly contiguous.

Antennae (Fig. 32*A*) 16-segmented, shorter than the width of the wing disc, 1st segment subcylindrical, about twice as long as wide, 2nd spherical, those of the flagellum (Fig. 32*B*) fusiform, gradually diminishing in size towards the extremity of the antenna, the last 3 spherical and presenting a marked contrast of shape with the preceding ones; last segment with an apiculus as long as the basal bulb. Ascoids present in pairs on segments 7-13, rather short, single, double or 3-branched; on 1 of the antennae of the type the arrangement is as follows: segment 7, 1 single and 1 threble; 8th, 1 single and 1 double; 9th, 1 double and 1 threble; 10th, 2 threble; on the following 3 segments there is only 1 ascoid which is either 2- or 3-branched; this arrangement is apparently not always constant and it is somewhat different on the other antenna of the type. *Palpi*: formula: 6 : 11 : 12 : 20, the last segment (Fig. 32*C*) thinner than the others.

No sense organ present on the thorax, *legs* with a slightly darker covering than on the rest of the body.

Wings ovate-lanceolate; with the roundish apex (Fig. 32*D*) placed just a little above the tip of R_5; the 2 forks well towards the base of the wing so that the stem of the anterior one is less than 1/5 of the branch R_2; posterior fork a little more distad, both well before the tip of *Cu*; origin of the stem of the anterior fork somewhat past the apex of the 1st basal cell which is noticeably longer than the 2nd basal cell.

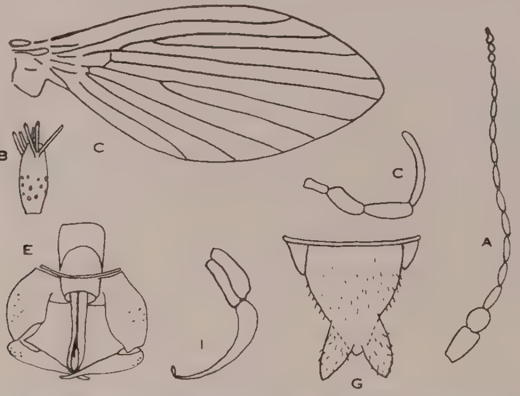

Fig. 32.—*Pericoma uniformata*, sp. nov. *A*, antenna; *B*, flagellar segment; *C*, palp; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, subgenital plate.

Vestiture of wing uniformly brownish without tufts or markings; the rows of erect hairs absent on R_5 and M_4; on R_1, R_2, M_2, and *Cu* they reach the tip of these veins; on R_4 and M_1 they stop at about the level of the tip of R_2, but on R_3 and M_3 they do not reach the middle of these branches.

Hypopygium (Fig. 32*E*) with the basistyles rather long, dististyles almost straight, incrassate at the base but gradually tapering to a fine point; aedeagus long and narrow and apparently composed of 3 pieces, 1 fine median stylet (the penis?) and 2 blade-shaped longer processes with blunt apex (the parameres?). Cercopods (Fig. 32*F*) long, thin, gradually tapering, and curved with 1 stout retinaculum at apex; no pseudospiracular openings on the 9th tergite.

Female

Similar to male but somewhat larger and a little darker; antennae with the ascoids present in pairs on segments 4-13 mostly 3-branched. Subgenital plate as in Figure 32*G*, the 2 lobes mounted on an olive-shaped plate, the apex of which emerges between the bases of the lobes.

Type: King River, 4.ii.1923.

Allotype and 1 ♂ paratype: Cradle Valley, 23.i.1923.

This species comes near some Chilian ones that Enderlein (1936) has placed in 1 of his genera, *Didicrum*, characterized by long forks, the anterior before the posterior, the last 3 segments of the antenna spherical but not narrower than the preceding ones which are fusiform, the ascoids multibranched. This genus has no real standing; it is even doubtful if it can be accepted as a subgenus.

Pericoma punctulata, sp. nov.

Fig. 33

Species with golden brown covering, the wings with darker tufts at the forks and the tips of veins; the 2 forks at the same level a little before the tip of the wing. Tarsi annulated.

Length of wing 3 mm.

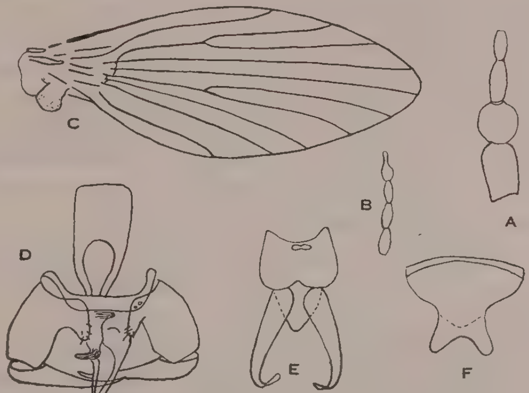

Fig. 33.—*Pericoma punctulata*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, venation; *D*, hypopygium. *E*, cercopods; *F*, subgenital plate.

Male

Eye bridges separated by a gap as wide as 3 facets; head covering brownish grey, erect on the face but not forming any conspicuous tuft. *Antenna* (Fig. 33*A*) with the 1st 2 segments covered with brownish grey scales and hairs, the scape with a small tuft of longer hairs on the internal side; basal segments of the flagellum elongate-fusiform, the following ones gradually diminishing in size, the 15th ovoid (Fig. 33*B*), the last subspherical with a long club-shaped apiculus. Ascoids present in pairs on segments 6-14, 1 only on segment 5; they are straight, moderately long, and sometimes one is smaller than the other on the same segment. *Palpi*: formula 11 : 24 : 27 : 30.

Mesothorax with a greyish covering tinged with brown, especially on the sides and posteriorly; no patagia and apparently no allurement or display organ on the side of the thorax. *Legs*: femora and tibiae greyish brown, darker brown on the tarsi; tip of tibiae and tarsal segments with a narrow white edging dorsally; this edging is little conspicuous on the tibiae.

Wing: elongate oval (Fig. 33*C*) with the apex somewhat above the tip of R_5; the 2 forks at the same level, very little before the tip of *Cu*, somewhat before the middle of the wing; origin of the stem of anterior fork at the apex of the 1st basal cell, the 2nd basal cell a little shorter than the 1st; base of *Cu* not connected with M. Wing covering golden brown, some of the erect hairs on the veins whitish, others dark; some of the divaricate adpressed hairs are also dark brown and form some spots at the forks and at the tips of the veins, except that of R_1; the tuft at the end of M_4 little conspicuous; some divaricate adpressed hairs also present on the distal portion of the veins just after the ending of the rows of bristling erect hairs on R_3, R_4, M_1, and M_2; these hairs absent on R_1, R_5, and M_4, but present on the basal part of the costa, which is a rather unusual feature. The bristling erect hairs are whitish on *Cu* except in the middle of that vein where they are brown on a space equal to each of the white spaces on either side. The row of erect hairs on that vein ends right against the terminal tuft of darker hairs; on R_2, R_3, and R_4 the rows of erect hairs are ending at about the same level, that is, just before the apical darker tuft of R_2; the end of the rows on M_1, M_2, and M_3 are a little more proximal, that is, about at the level of the dark apical tuft of M_3. Fringe uniformly golden brown even at the wing apex, but in the vicinity of the tip of M_4 and *Cu* there are a few longer darker hairs mixed in with the others.

Covering of the abdomen matching that of the thorax.

Hypopygium (Fig. 33*D*): ninth sternite more developed than usual, in form of a transverse straight band; coxites subcylindrical and with a small process at their base internally; these processes carry 4-5 sensory setae; styles gradually tapering, almost straight, their base moderately swollen; aedeagus complicated, provided dorsally with a strongly chitinous hook curved on 1 side; median piece broadly triangular. Tergite with the pseudospiracles contiguous and placed right at the base; cercopods (Fig. 33*E*) rather thin, at least twice as long as the tergite, somewhat curved inwards as well as upwards and provided with a single retinaculum at apex.

Female

Similar to male so far as the moderately good condition of the only available specimen of that sex allows to judge; the venation and other morphological details agree well with that of the other sex; the locality where it was obtained is not far distant from that of the type. The antennae have a pair of ascoids on segments 4-15, which are shaped as in the male. Subgenital plate with diverging, well-developed lobes, as shown in Figure 33*F*.

Type: Sassafras, 20.x.1922.

Allotype: Ferntree Gully, 5.x.1921.

PERICOMA ILLUSTRATA, sp. nov.

Fig. 34

A grey and pale brown species, the wings speckled with black and white spots; the 1st antennal segment of the male very long and produced distally on the internal side.

Length of wings: ♂ 2.5 mm, ♀ 3 mm.

Male

Head covering not forming any distinct tuft, scaly hairs on the frons whitish, erect, those of the vertex longer, brownish, and reclined; eyes not touching.

Antennae much shorter than the width of wing disc, their integument pitch brown; 1st segment much elongated and produced into a tapering but blunt apical prolongation on the internal side (Fig. 34*A*); 2nd segment subspherical; the basal segments of the flagellum fusiform, the distal ones more ovoid the nearer the tip of the antennae, last segment nearly spherical with a cylindrical apiculus nearly as long as the basal bulb. *Ascoids* moderately developed (Fig. 34*B*); somewhat curved in spiral and present in pairs on segments 5-14 (even on the 15th in some specimens). *Palpi*: formula 11 : 17 : 17 : 26.

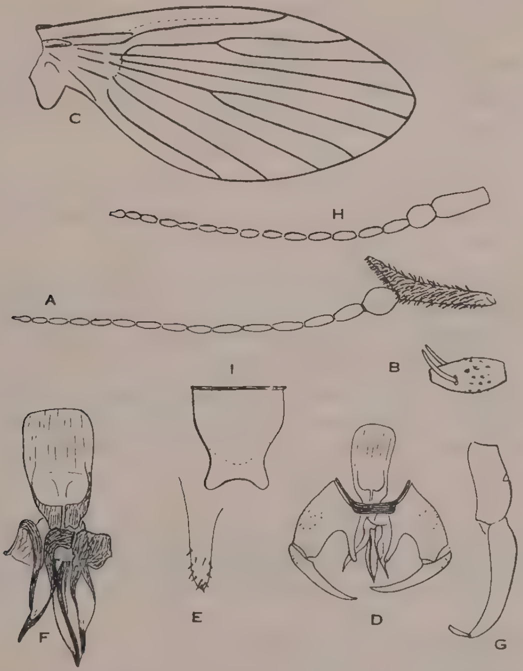

Fig. 34.—*Pericoma illustrata*, sp. nov. *A*, ♂ antenna; *B*, flagellar segment; *C*, venation; *D*, internal process of basistyle; *E*, hypopygium; *F*, aedeagus; *G*, cercopod; *H*, ♀ antenna; *I*, subgenital plate.

Mesonotum with greyish covering in which only a few brown hairs are intermixed; no patagia or other sense organ on the side of the thorax. *Wings* oval (Fig. 34*C*) with rounded apex placed between the tips of R_4 and R_5; anterior and posterior forks placed at the same level somewhat before the middle of the wing and before the tip of *Cu*; origin of the stem of the anterior fork exactly at the apex of the 1st basal cell; origin of *Cu* in front of *M* but actually not in contact with it; a distinct fold is present in the costal field in prolongation to *Sc*.

Wing covering brown with whitish and blackish spots formed by small hair tufts and arranged in the following manner: a black tuft of erect hairs on each of the forks; a small black tuft of recumbent hairs at the tip of all the longitudinal veins; on the disc the white tufts of recumbent divaricate hairs are placed at the end of each of the rows of erect bristly hairs on the longitudinal veins, this tuft on *Cu* is at the level of the dark tufts on the forks; the 2 tufts on R_3 and M_2 are placed a little more distally; the tuft on R_2 is nearly at the tip of that vein, that is, at the same level as that on M_1 whereas the one on M_3 is a little more basal; the tuft on R_3 is the most distal of all. Besides these white recumbent hairs there are a number of erect bristly white hairs at the base of the wing on *Sc*, R_1, M_4, and *Cu*, on which they form definite rows, whereas on the other veins they are scattered here and there. The costa carries also a row of bristly erect white hairs on its basal 1/3, they are inserted nearly at right angles to the usual hairs of the fringe. Fringe brown with 3 narrow whitish spaces; 1 at the tip of R_1, then at the apex of the wing between the tips of R_4 and R_5, and the 3rd at the tip of M_4.

Legs with brown coverings, fringe of mid and hind tibiae paler; tip of all tibiae and of the 1st tarsal segment with white scales dorsally, the whole dorsum of the 2nd tarsal segment covered with white scales.

Abdomen with vestiture similar to that of the thorax, greyish with a touch of brown. Hypopygium with the basistyles provided with an internal process which carries a few sensory setae on its blunt apex (Fig. 34*E*); dististyle falciform (Fig. 34*D*); aedeagus complicated and composed of 3 pieces, the median one being the penis and the others the 2 asymmetrical parameres (Fig. 34*F*); cercopods not quite twice as long as the 9th tergite and provided with only 1 retinaculum (Fig. 34*G*); pseudo-spiracular openings of the tergite fused together.

Female

Similar to the male but for the wings, which are somewhat narrower; antennae a little shorter, the flagellar segments not being so elongated (Fig. 34*H*); ascoids as in the male. Subgenital plate with small lobes as shown in Figure 34*I*.

Type: Mount Wellington, 28.xi.1922.

Allotype: Same locality, 25.xi.1922.

Paratypes: 5 ♂ and 6 ♀ from the same locality and Harz Mt., 9.xii.1922.

Two paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

PERICOMA SUBILLUSTRATA, sp. nov.

Fig. 35

A relatively large species very similar to *P. illustrata* (in the ♀) but differing in the absence of white spaces in the wing fringe except at the apex where the white space is larger.

Length of wing 3.75 mm.

Female

Covering of head, thorax, and abdomen whitish grey. *Antenna* relatively short, a little over ½ the width of the wing disc; scape with whitish hairs and scales, verticils of flagellum brownish; flagellar segments ovofusiform (Fig. 35*A*); ascoids of the usual shape and present in pairs on the segments 4-15, last segment with a cylindrical apiculus at least as long as the basal bulb.

Palpi (Fig. 35*B*): formula as in *P. illustrata.*

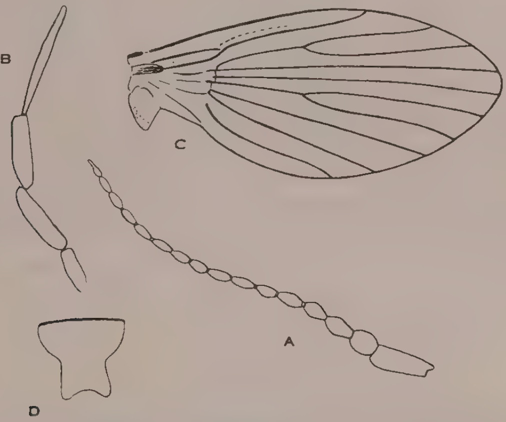

Fig. 35.—*Pericoma subillustrata,* sp. nov. *A,* ♀ antenna; *B,* ♀, palp; *C,* ♀ venation; *D,* subgenital plate.

Wing venation (Fig. 35*C*) exactly as in the latter species; the fold in the costal field is also present and the position of the forks and the length of the basal cells are quite similar, but the total length is greater, reaching 3.75 mm instead of 3 mm.

Wing covering also similar to that of *P. illustrata* but more extensively white on the basal portion, before the dark tufts of the forks. The position of the little white tufts at the ends of the rows of erect hairs differs only in that the 3 tufts on M_1, M_3, and M_4 are placed closer together and at the level of the tufts on R_2 and R_3 so that the tuft on R_4 stands more on its own distally; the erect white hairs on the costa are more conspicuous. Fringe white at the apex only, from the tip of R_2 to that of M_1. *Legs* as in the preceding species but the dorsum of the 2nd tarsal segment more conspicuously white.

Subgenital plate as in Figure 35*D*; the basal wide part is shorter and the distal narrower part is more elongate than in *P. illustrata.* Male unknown.

Type ♀ and paratype: Harz Mt., 9.xii.1922.

PERICOMA TASMANIAE, sp. nov.

Fig. 36

A pale brown species of uniform coloration, no white parts on wing or its fringe, but 2 darker tufts at the forks which are situated above the middle of the disc, the anterior one placed a little before the posterior one which is just in front of the tip of *Cu.*

Wing length 3 mm.

Male

Eye bridges separated by a distance equal to 2 facets. *Antennae* less than ½ width of wing; 1st segment about as long as wide, flagellar segments (Fig. 36*A*) fusiform, the middle ones slightly more tapering distally, the distal ones more oval, the last with a subcylindrical apiculus as long as the basal bulb (Fig. 36*B*). Ascoids rather small, curved, single on segments 4-7, 9, 11, and 13, in pairs on segments 8, 10, 12, and 14; one of the pair is smaller than the other. (This arrangement refers to the holotype, but may vary somewhat according to the specimen.) *Palpi*: formula 8 : 12 : 12 : 17.

Anepisternite with an exsertile vesicle covered with deep black scales (Fig. 36*C*) except at its rounded apex, which is provided with dense round papillae. When retracted these organs are quite distinctly seen in the form of small black epaulettes. *Legs* with very faint and narrow paler rings at tip of tibiae and tarsi when seen in certain lights at about × 24.

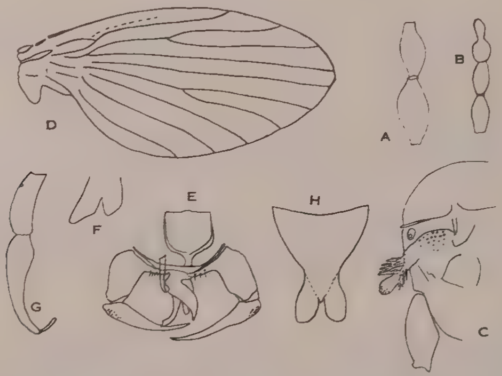

Fig. 36.—*Pericoma tasmaniae,* sp. nov. *A,* flagellar segments of antenna; *B,* tip of antenna; *C,* allurement organ; *D,* venation; *E,* hypopygium; *F,* tip of main element of aedeagus; *G,* cercopod; *H,* subgenital plate.

Wing (Fig. 36*D*) oval, rather broad, its apex rounded and placed somewhat below the tip of R_4; *Sc* ending in R_1, a fold of the costal field in prolongation of *Sc*; posterior fork at the level of the tip of *Cu*, anterior fork a little more basal; both basal cells of equal length.

Vestiture of wing of uniform greyish brown coloration except on the disc where there are 2 inconspicuous darker tufts on the forks; erect hairs present on all the veins including R_5 and M_3 but on these 2 veins they are less dense and do not extend very far, whereas they reach almost to the tips of the other veins. A patch of dense long scales present on the under side of the base of the wing on the veins in the vicinity of the basal cells.

Hypopygium (Fig. 36*E*) of a similar type to that of *P. intricatoria,* the base of the coxites being prolonged internally and there provided with a number of sensory setae; styles somewhat longer than coxites, gently curved and gradually tapering. Aedeagus asymmetrical, composed of 4 pieces as shown in Figure 36*E, F*. Cercopods almost ½ as long again (Fig. 36*G*) as 9th tergite, curved and gently tapering with only 1 retinaculum at apex.

Female

As in male; ascoids single on segment 4, in pairs on segments 5-14. Subgenital plate (Fig. 36*H*) elongate with 2 large parallel apical lobes.

Holotype and allotype: Maria I., 6.xi.1933.

Paratypes: 3 ♂ with type, and also at Weldboro Pass, 25.x.1933.

In the male from Weldboro Pass the pieces of the aedeagus are inverted so that they bend and point towards the other side, but are otherwise in the same order from above below.

At the time of collecting it was not noticed if the live insects were holding their wings folded obliquely on the sides of the body; however, it is almost certain that this was the case, otherwise I would have recognized at once it to be a new find whereas I took them to be specimens of *P. intricatoria.*

PERICOMA ALBIPES, sp. nov.

Fig. 37

A somewhat brownish black species with wings rounded at apex, where the fringe is white; tarsi white.

Length of wing 1.75 mm.

Male

Head with moderately long brownish grey vestiture, not forming any special tuft on vertex or face. *Antenna* relatively short, about ½ as long as the width of the wing; 1st segment but little longer than wide, the 2nd spherical, both conspicuously wider than the segments of the flagellum which are fusiform and little elongated (Fig. 37*A*); the last one subspherical with a club-shaped apiculus (Fig. 37*B*) as long as the basal bulb itself; verticils of the flagellar segments greyish with few longer hairs only; 2 ascoids of moderate length directed in opposite directions are present on all flagellar segments from the 5th to 14th. *Palpi*: formula 8 : 11 : 13 : 19, their covering not specially dense, greyish brown in colour.

Thorax with erect, moderately dense greyish brown covering which does not form any tuft. In the middle of the anepisternite there is a small spherical vesicle rather densely covered with papillae (Fig. 37*C*); these organs are fairly sclerotized like the surrounding integument, and do not appear to be erectile, but retain their hemispherical shape. *Legs* brown, tarsi white.

Wings rather broad, their apex placed between the tips of R_4 and R_5 (Fig. 37*D*); anterior fork distinctly before the posterior one and both before the middle of the wing and before the tip of *Cu*; origin of the stem of R_{2+3} placed at apex of anterior basal cell. Wing covering brownish, rather uniform in density, a small tuft on the posterior fork, rows of erect hairs reaching the tip of R_2 and Cu, stopping at a short distance from the tip of all the other veins. Fringe moderately long, brown except at the wing apex where it has a yellowish white colour on a space which seems to vary in length according to the incidence of the light, it extends distinctly from a little past the tip of R_2 to a little before that of M_1. Abdomen with a covering similar to that of the thorax.

Hypopygium.—Basistyle longer than broad (Fig. 87E), curved outwards and with a basal internal prolongation, dististyle incrassate at base and ending in a very slightly curved elongated beak, aedeagus formed of 2 pointed pieces curved in opposite directions (Fig. 87E, F), cercopod (Fig. 87G) more than twice as long as the 9th tergite, its retinaculae as in *P. intricatoria*.

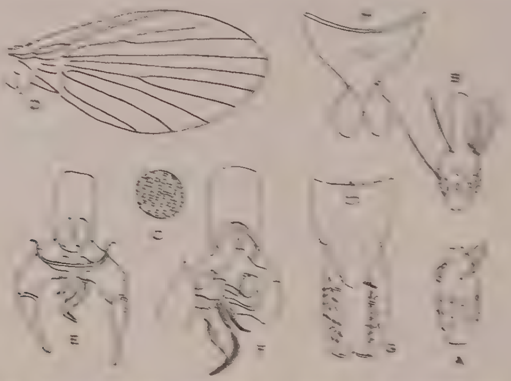

Fig. 87.—*Pericoma albipes*, sp. nov. A, flagellar segment of antenna. B, terminal segment of antenna. C, allurement organ. D, venation. E, hypopygium. F, aedeagus. G, cercopods. H, subgenital plate.

Female

Antennae similar to male; wing relatively narrower but venation identical, subgenital plate as in Figure 87*H*.

Type, allotype, 9 ♂, 1 ♀, paratypes: Narara, 8.xi.1921.

Paratypes: 8 ♂, 8 ♀, Wentworth Falls, 18.xi.1921. 2 ♂, 1 ♀, Waterfall, 8.xi.1921. 4 ♂, 8 ♀, Blundells, 7.i.1930, 16.x.1930, and other dates.

Other specimens: 3 ♂, 2 ♀, Mt. Kosciusko, 14.ii.1934. 6 ♂, 6 ♀, Fitzroy Falls, 22-27.xi.1937. 9 ♂, 2 ♀, Shannon Creek, 18.xi.1938. 17 ♂, 10 ♀, Narooma, Jan. 1940. 1 ♂, Belmore Falls, 2.x.1938. 1 ♂, 1 ♀, Blundells, 18.xi.1938. 1 ♀, Mt. Tilba Tilba, 29.x.1939. 2 ♂, Stanwell Park, 29.x.1938.

Four paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

The ♀ could easily be confused with that of *P. intricatoria* were it not for the complete absence of darker reclined tufts on the anterior fork, the longer rows of erect hairs, which reach the tip of almost all the longitudinal veins, and the smaller size.

PERICOMA ROTUNDIPENNIS, sp. nov.

Fig. 38

A blackish brown species with white tarsi, the wing of the male broad, oval, and thickly covered with broad scales on the under side, particularly along the veins; wing tip white.

Length of wing 2.3 mm.

Male

Head with thick black covering, erect on the face; eye bridges 5 facets wide and separated by a distance equal to 2 facets. *Antennae* about ½ as long as width of wing, the flagellar verticils whitish, the scape with thick black covering. First segment (Fig. 38*A*) somewhat longer than wide, the 2nd oval, those of the flagellum fusiform, gradually diminishing in size towards the tip of the antenna, the 15th (Fig. 38*B*) being still twice as long as broad. the last 1 with a claviform apiculus as long as the bulb itself.

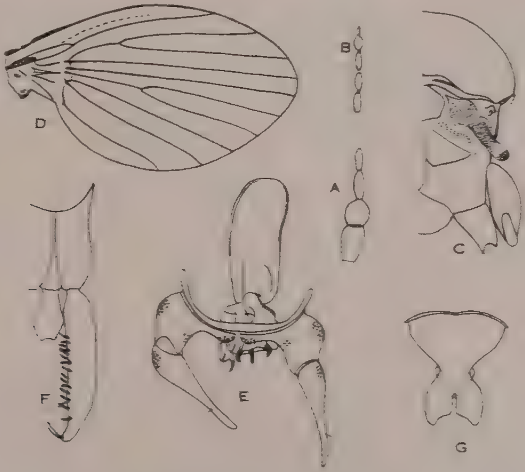

Fig. 38.—*Pericoma rotundipennis*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, allurement organ; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, subgenital plate.

Palpi: formula 2 : 2 : 3 : 4. as long as the antennal flagellum and very densely covered with black scales.

Thorax with vestiture similar to that of *P. intricatoria*, but the anterior part of the notum covered with short greyish brown scales; the posterior part with long, erect brown hairs. Anepisternite with a tuft of dark scales forming an epaulette under which are hidden the exsertile vesicles (see Fig. 38*C*), similar to those found in *Pericoma fusca* Macq. The shaft of this vesicle is covered with scales; it does not seem to be dilatable to a large extent; its rounded apex carries numerous papillae. *Legs* black, tarsi white.

Wing (Fig. 38*D*) much rounded, width equal to 3/5 of length, its apex between the tips of R_4 and R_5; *Sc* ending in R_1 but continued by a fold in the costal field. Anterior fork before the posterior one which is placed distinctly before the tip of *Cu*. Origin of stem of anterior fork very little before the apex of the 1st basal cell which is of equal length to the 2nd basal cell. Wing membrane uniformly brownish. *Wing covering* blackish brown without definite darker tufts at the forks or at the end of veins. Fringe whitish from a point before the tip of R_3 to a little past the tip of M_1. The rows of erect hairs absent on R_1, R_5, and M_4; they extend to about the middle of the wing except on R_2 where the bristles reach only to the level of the tip of R_1; the row on *Cu* does not reach the tip of that vein. On the under side the veins are covered practically up to the tip with scales which are broad and dense on the basal ½ of the wing, longer and mixed with same hairs on the distal ½.

Abdomen with brown covering; *hypopygium* (Fig. 38*E*): coxites short, rounded, bulging externally, and prolonged towards each other at the base in a lobe provided with sensory setae; style incrassate but not bulbous at base, its beak nearly straight and gradually tapering; aedeagus complicated, formed of several pieces, 1 being 3-branched as shown in Figure 38*E*; cercopods (Fig. 38*F*) subcylindrical but distal portion suddenly narrowing, 1 apical and a number of smaller dorsal retinaculae as in *P. intricatoria*.

Type, 3 ♂, 1 ♀ paratypes: Narooma, 27.xi.1930.

Allotype: Narooma, Jan. 1932. Miss K. English.

Other specimens: 7 ♂, 25 ♀, Narooma, Jan. 1940. 1 ♂, Fitzroy Falls, 22-27.xi.1937.

A paratype* and three other specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

PERICOMA INTRICATORIA, sp. nov.

Fig. 39

A fairly large size brownish black species; tarsi and apex of rounded wings white; under side of wings with narrow scales on basal ½ in the male; covering of the notum mostly black anteriorly in that sex.

Length of wing 2.5 mm.

Male

Covering of the head dark, not forming any tuft on the vertex but with a small one on the face directed downwards; eye bridges not touching. *Antennae* 16-segmented, short, about ½ as long as the width of the wing disc; the 1st 2 segments with dark covering; the flagellum pale with greyish bushy hairs which do not form cupuliform verticils; scape subcylindrical (Fig. 39*A*) ½ as long again as wide; pedicel spherical; flagellar segments fusiform, the basal ones over twice as long as wide, the terminal ones not quite twice as long as wide,

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* One specimen, labelled by Tonnoir as a ♀ paratype of this species, is a specimen of *P. albipes*. The allotype, from which Tonnoir's Figure 38*F* was drawn, is correctly identified. There is no descriptive matter relating to the ♀ of this species in Tonnoir's MSS notes. (G.H.S.)

the last segment (Fig. 39*B*) subspherical with a somewhat club-shaped apiculus nearly as long as the basal bulb. Ascoids (Fig. 39*C*) present in pairs on segments 6-14, moderately long, and only slightly curved in a spiral fashion. *Palpi* as long as the antennae, very thickly covered with deep black scales; the segments gradually increasing in length; palpal formula 8:16:18:20, the last one thin.

Mesonotum with thick, short, and deep black covering anteriorly, longer and more greyish brown posteriorly between the wing bases. On the anepisternites there is a sensory organ (Fig. 39*D*) which reminds one of the one found in *Pericoma trivialis* Eat. at the same place but in this case it is much less protruding and is more sclerotized; it consists of a brownish mushroom-shaped knob densely covered with papillae and of a basal transparent membrane connecting the knob to the body; this organ may therefore be erectile to a certain extent; it is usually hidden amongst the long dense black hairs which cover the anepisternites. *Legs* with brown covering; the ventral and dorsal fringe of the mid tibiae particularly long and dense; tarsi white, last segment darker.

Wing (Fig. 39*E*) rounded, not quite twice as long as broad, its apex between the tips of R_4 and R_5; Sc runs in a straight line into R_1; anterior fork distinctly before the posterior one, which is placed on the middle of the disc and a little before the tip of Cu; origin of the stem of anterior fork placed exactly on the apex of the 1st basal cell; base of Cu not actually connected with the fork of M_3 M_4.

Wing covering brown with a darker tuft on each of the forks, that of the anterior fork less conspicuous; also some darker tufts at the tip of the longitudinal veins; these tufts are more distinct on the posterior margin, being there more spaced; fringe brown except at the apex between the tip of R_3 to below the tip of M_1, where it is whitish yellow. Under side with narrow scales gradually merging into ordinary hairs on at least the basal ½ of all the veins. Rows of erect hairs absent on R_1, R_5, and M_4 (except at the very base of that vein); on R_3 and the others only to about the level of the tip of R_1; these hairs are darker and denser in the vicinity of the forks where they form consequently two ill-defined darker tufts, the posterior one being the larger; on the outside of these tufts a few of the recumbent hairs appear paler in certain positions.

Covering of the abdomen greyish brown, the cercopods with very dense erect deep black scaly covering. *Hypopygium* (Fig. 39*F*): coxites longer than broad, somewhat curved, their bases extended towards each other and provided there with a few sensory setae; styles somewhat bulbous at the base and then gradually tapering into a fine nearly straight point; on its last 1/3 there is a small dorsal sensory seta; aedeagus formed of a large, pointed, somewhat triangular piece, a small strongly sclerotized forked one, and a rounded piece; internal basal prolongation of the genital armature rather elongate and complicated as shown in Figure 39*F*. Cercopod not quite twice as long as the tergite itself, its base slightly swollen, its shape cylindrical but its distal portion suddenly narrower; tip rounded with a single retinaculum pointing inwards. Besides these, there are, along the dorsal face of the cercopod, about 17 smaller retinaculae which could be confused at first with the usual covering of these appendages. However, they are of the same nature as the apical retinaculum. They are not deciduous like the rest of the covering and are inserted on a raised socket; when examined under high power they are seen to have microscopic rows of fine hairs (Fig. 39G). These smaller retinaculae are of various lengths and point in all directions.

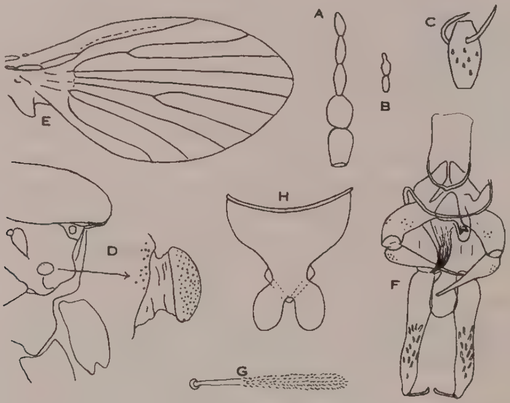

Fig. 39.—*Pericoma intricatoria*, sp. nov. *A*, base of antenna; *B*, tip of antenna; *C*, flagellar joint; *D*, allurement organ; *E*, hypopygium and cercopods; *F*, a bottle-brush-like retinaculum.

Female

Similar to male but the covering of the head, palpi, and anterior part of the mesonotum paler, greyish brown. Antennae somewhat shorter, the flagellar segments not being as elongate and appearing less pale; ascoids just as well developed and present on segments 4-14; under side of the wing devoid of scales; subgenital plate with 2 very strongly developed lobes as shown in Figure 39*H*. Ovipositor normal.

Type, allotype, 8 ♂, 3 ♀ paratypes: Burnie, 24.x.1922 and 21.x.1933.

Paratypes: 6 ♂, 4 ♀, Eaglehawk Neck, 18.xi.1922. 5 ♂, Blundells, 16.x.1930. 5 ♂, Devonport, 18.x.1933. 2 ♂, 4 ♀, Sassafras, 22.x.1922. 6 ♂, 5 ♀, Ferntree Gully, 25.x.1921. 2 ♂, Snowy River, 12.xii.1931. 1 ♂, Geeveston, 8.xii.1922. 1 ♂, Diggers Creek Fall, Mt. Kosciusko, 5300 ft, 10.xii.1931. 3 ♂, Mt. Kembla, 12.ii.1933. 1 ♀, Maria I., 6.xi.1933.

Other specimens: 2 ♂, 5 ♀, Blundells, 13.x.1938. 1 ♀, Devonport, 18.x.1933. 3 ♂, 2 ♀, Fitzroy Falls, 22-27.xi.1937. 6 ♂, 4 ♀, Shannon Creek, 20.xi.1939. 5 ♂, 2 ♀, Macquarie Pass, 23.xii.1934. 2 ♂, Brown Mt., 25.ii.1939. 1 ♂, Snowy River, 12.xii.1931. 1 ♀, Ferntree Gully, 28.iv.1931, Deane. 1 ♀, Ferntree Gully, 25.x.1921.

Six of the specimens (including 5 paratypes) are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

TELMATOSCOPUS TOWNSVILLENSIS (Taylor)

Fig. 40

Telmatoscopus townsvillensis Taylor, 1915, Bull. Ent. Res. **6**: 267.

Male

Eye bridges not touching, 4 facets wide. *Antenna* longer than width of wing; 16-segmented, 1st segment 3 times as long as wide; the segments of the flagellum with basal bulb (scarcely eccentric) and distal neck; this neck very short on the basal segment and somewhat shorter than the bulb on the median and distal segments. Ascoids spiraliform (Fig. 40*A*), well developed, in pairs, insertions not far removed from each other, their bases incrassate, found on segments 3-15; segments 16 with a long, rather thin apiculus somewhat club-shaped (Fig. 40*B*). *Palpi* long, 2nd segment not quite twice as long as 1st, 3 subequal to 2, 4th thin, longer by ½ (Fig. 40*C*, *D*).

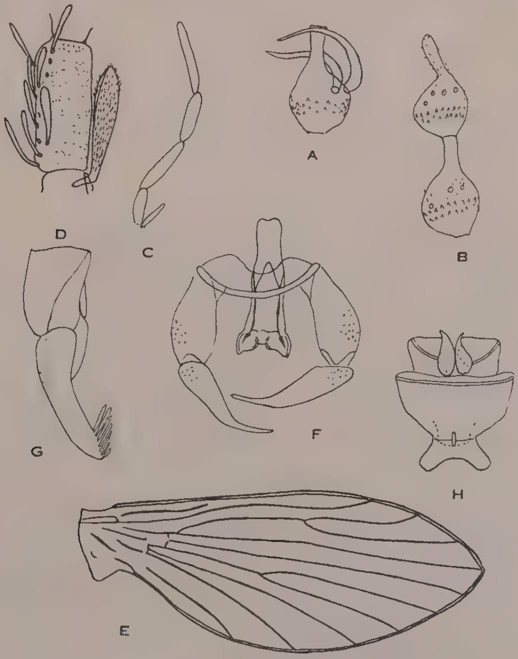

Fig. 40.—*Telmatoscopus townsvillensis* Taylor. *A*, flagellar segment of antenna; *B*, tip of antenna; *C*, palp; *D*, 1st palpal segment; *E*, venation; *F*, hypopygium; *G*, cercopod; *H*, subgenital plate.

Wing (Fig. 40*E*) ovate lanceolate, *Sc* well developed, R_4 at apex of wing, anterior fork past posterior one, and at level of tip of M_4, somewhat past the middle of the disc. Origin of R_{2+3} on R_4 at a distance past the apex of the

1st basal cell equal to width of that cell at apex; 2nd basal cell noticeably shorter than the 1st.

Sternite narrow and bridge-like; basistyle (Fig. 40*F*) twice as long as broad, the dististyle falcate, last 1/3 suddenly tapering; penis of simple structure, parameres apparently absent. Cercopods short (Fig. 40*G*), almost straight, base somewhat swollen, and carrying on last ¼ about 10 retinaculae, the shortest being distal and the longest proximal. Tergite with only 1 spiracular opening.

Female

Antennae apparently shorter than in male, the ascoids less developed, but more incrassate at base. Apiculus of last segment longer and rather irregular in shape. The rest as in male. Ovipositor normal, *subgenital plate* semicircular at base, the 2 lobes diverging as in Figure 40*H*.

Paratype: ♀, Townsville, Queensland (no date), F. H. Taylor.

Other specimens: 1 ♂, 4 ♀, same locality, June 1927, G. Dennes.

TELMATOSCOPUS (NOTOTELMATOSCOPUS) GREGSONI, sp. nov.

Figs. 22*E*, *F*; 41

A rather large brown species with white tarsi and moderately long antennae; anterior fork before the posterior one; fringe entirely dark; male with long erect tufts on the side of the mesonotum.

Male

Head with short black pubescence on the vertex and a black, moderately long tuft on the face. *Antennae* a little shorter than the width of the wing; 1st segment subcylindrical, 2nd spherical, both covered with dense black, rather short scales; basal segments of the flagellum fusiform (Fig. 41*A*), the more distal segments gradually assuming the typical shape of the antennal segments of the genus *Telmatoscopus*; that is, with a basal bulb and a more or less elongate distal neck; last segment with an apiculus as long as the bulb which is somewhat squarish. Each segment of the flagellum is provided on the distal part of the bulb with a crown or verticil of ascoids; the 3rd segment carries about 18 of them but the verticil is not complete on the internal side; the other segments have gradually less ascoids but the 12th still carries 12 of them; these are secondary ascoids and there is a pair of somewhat thicker ones on the protruding part of the bulb. The verticils of hairs on the flagellum are greyish and form a distinct contrast with the black covering of the scape. *Palpi* with a covering composed of black scales; 1st segment ½ as long as the 2nd, this one subequal to the 3rd; the 4th nearly twice as long as the 3rd (Fig. 41*B*).

Mesonotum with a peculiar covering composed of a patch of very short black scales on the anterior part of the disc on each side of which stands a conspicuous erect tuft of black hairs, obliquely leaning towards the base of the wing; posteriorly the covering of the mesonotum is also long but not so dark. *Anepisternite* with a dense vestiture of black scales anteriorly and of longer hairs posteriorly. On each side, above the head, there is a patagium-like organ (Fig. 41*C*) similar to that of *Pericoma fusca* and *auriculata*, but it is not erectile, it is curved and pointing downwards. It is thicker at the base; its texture is strongly sclerotized, and it is therefore not dilatable; its colour is brownish and carries a number of papillae which are dense at the tip and on the anterior side. There is no organ on the anepisternite.

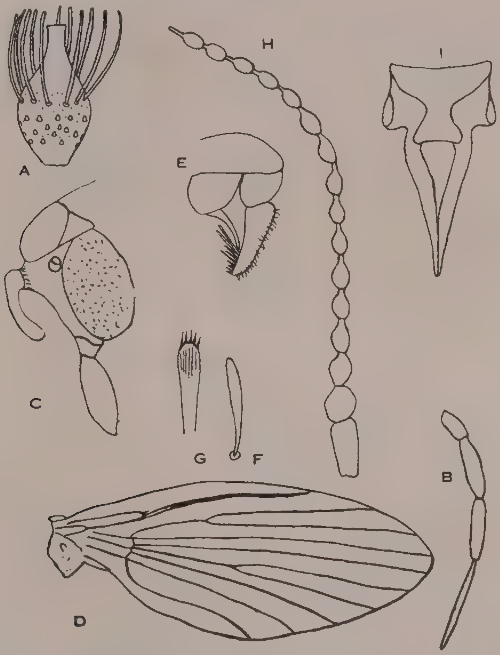

Fig. 41.—*Telmatoscopus gregsoni*, sp. nov. *A*, basal flagellar segment; *B*, palp; *C*, allurement organ; *D*, venation; *E*, hypopygium (lateral view); *F*, distal, and *G*, proximal retinaculae; *H*, ♀ antenna; *I*, subgenital plate.

Legs brown with greyish white tarsi, dorsal fringe of posterior tibiae long. *Wings* (Fig. 41*D*) rather elongate, oval, with rounded apex placed a little below the tip of R_4; fork of $R_2 + R_3$ placed distinctly before that of $M_1 + M_2$ which is on the middle of the wing and a little before the tip of *Cu*; origin of $R_2 + R_3$ at apex of basal cell; *Cu* united at base, with M_4. The wing covering is uniformly brownish black with 3 darker little tufts, 1 at each of the forks, and the last at the tip of *Cu*; row of erect hairs absent on R_5 and M_4 and extending the furthest on R_2 where it nearly reaches the tip of that vein; the rows on the following veins extend gradually less further; those on M_1 to M_3 scarcely extending beyond the posterior fork. Fringe uniformly dark and moderately long.

Abdomen with greyish brown covering; *hypopygium** small, coxite rounded, styles twice as long (Fig. 41*E*), gradually tapering, curved downwards and inwards; aedeagus symmetrical ending in 2 rounded inferior lobes; cercopods with 8-9 small retinaculae (Fig. 41*F*) and 5-6 longer proximal ones (Fig. 41*G*).

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* I have provided additional figures of the genitalia in Part I, Figure 22*E, F*. (G.H.S.)

Female

Length of wing 2.65 mm.

Wing similar to that of male; antenna a little shorter, the scape not covered with black, dense scales, the flagellum not greyish (Fig. 41*H*). Mesonotum with normal greyish brown covering. Segments of the flagellum as in the male; the neck a little shorter, a pair of rather long twisted ascoids on segments 4-14; *subgenital plate* as in Figure 41*I*. Wings somewhat narrower.

Type, 11 ♂, 4 ♀ paratypes: Mt. Wilson, 19.xi.1921.

Allotype: Ferntree, 25.x.1921. Paratype ♀, Sassafras, 22.x.1922.

Other specimens: 10 ♂, 12 ♀, Shannon Creek, 20.xi.1939. 6 ♂, 2 ♀, Blundells, 13.xi.1938.

Six specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

TELMATOSCOPUS (NOTOTELMATOSCOPUS) DIMORPHUS, sp. nov.*

Fig. 42

A dark brown species with white tarsi, venation with apparently 1 fork on the disc in the male, *Rs* 3-branched, normal in the ♀.

Male

Length of wing 2.25 mm.

Head with scanty brown covering on the vertex; an erect, thin, but rather long tuft on the face between the antennae. *Antennae* nearly as long as the width of the wing; 16-segmented, the 1st subcylindrical, 3 times as long as wide (Fig. 42*A*), the 2nd spherical, both covered with black narrow scales, which form on the inner side of the 1st one, a very conspicuous fan-shaped tuft which seems to belong to the head itself; segments of the flagellum with a basal bulb and a distal neck, but the neck of the 1st flagellar segment is very short and practically non-existent; this neck goes on increasing in length in the following segments (Fig. 42*B*) so that on the 12th it is about ½ as long as the bulb itself; the last segment with a moderately swollen apiculus (Fig. 42*C*), ascoids numerous, subcylindrical, similar to those found in *Pericoma fusca* but each of them has a distinct point of insertion or pore; they are arranged in 1 or 2 rows; there are about 34 ascoids on the 1st flagellar segment and their number goes on diminishing on the following ones so that on segment 3 they number only 20, on the 5th segment 15, on the 12th segment 6; there are a few more on the last segment (see Fig. 42*C*). The verticils of the flagellum appear greyish and contrast sharply with the dark coloration of the scales of the scape. *Palpi*

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* Tonnoir originally intended placing this species in a new genus—to be called *Australomyia*, but later sank this to subgeneric rank. However, its peculiarities are to me no more than the strong development of a sexual dimorphism. This trend is already visible in other members of the subgenus *Nototelmatoscopus* to which this species is otherwise closely allied, and I have therefore ignored Tonnoir's supposed new subgenus, and included *T. dimorphus* in *Nototelmatoscopus*. (G.H.S.)

(Fig. 42*D*): all the segments covered with moderately dense greyish brown scales.

Mesonotum with an erect blackish brown covering, shorter in front where it is composed mostly of scale-like hairs especially on the humeri; near the wing bases and between them the hairs are longer and thinner. The anepisternites are covered with very dense short black scales, there is also a tuft of black elongated scales immediately below the wing base on the hypotergites.

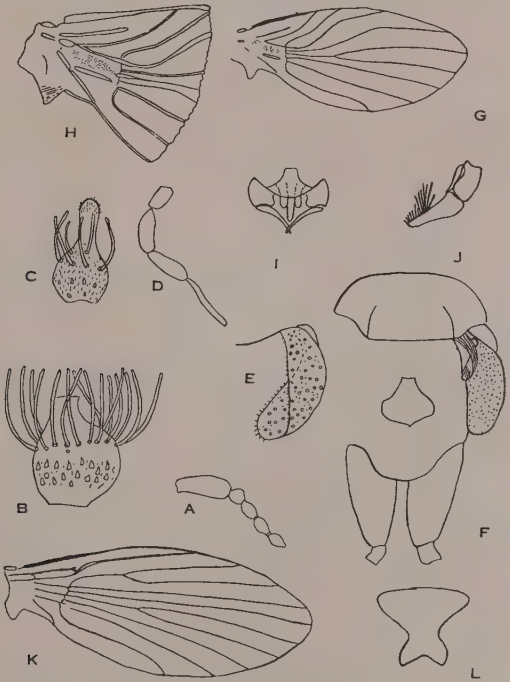

Fig. 42.—*Telmatoscopus dimorphus*, sp. nov. *A*, base of antenna; *B*, medial; *C*, terminal antennal segment; *D*, palp; *E*, allurement organ; *F*, position of allurement organ on thorax; *G*, ♂ wing; *H*, base of ♂ wing; *I*, hypopygium; *J*, cercopod; *K*, ♀ wing; *L*, subgenital plate.

On the membrane between the mesonotum and the head there is on each side a rather strongly chitinous brownish allurement organ (Fig. 42*E*), which does not seem to be erectile or exsertile; it is inserted just in front of the anterior spiracle at the angle formed by the mesonotum and the anepisternite (Fig. 42*F*). The exact conformation of this organ is rather difficult to make out, its chitinous portion is not tubular but can be compared to the external side of a flattened and somewhat twisted finger-glove-like structure, the internal side of which consists of a very thin and transparent membrane carrying numerous microscopic setae which are also present on the chitinous outside portion of the organ, besides the rounded papillae.

Wings oval, about ½ as long as wide, the apex rounded and placed at the tip of M_2; the venation is quite unusual (Fig. 42*G*) the radius and its sector being pushed upwards against the costa, by the spreading of the media over the centre of the disc; the radial sector has even lost 1 of its branches in the process and is either R_2 or R_3: the anterior fork is absent; R_{2+3} has its origin at the apex of the 1st basal cell; posterior fork is towards the middle of the disc, the fork itself about twice as long as its stem; *Cu* bent at right angles at the base, its origin on the fork of M_{3+4} (Fig. 42*H*). The 2 equal basal cells are very narrow on account of the very thick basal segment of *M* which divides them.

Wing covering uniformly blackish brown, but appearing darker on the base of the wing where it is denser and forms some tufts. On the upper side of the membrane there are no clumps or tufts of hairs; the rows of erect hairs are present on all the longitudinal veins except *Sc*, R_5, and M_4; they reach the tip of veins R_1, R_{2+3}, R_4, and *Cu* whereas on M_1, M_2 and M_3 they stop at the level of an imaginary line uniting the tips of R_5 and M_4. The fringe is uniformly and only moderately long on the hind border; at the tip of R_2 the fringe shows a rather long and downwards curved tuft which is tightly pressed against the under side of the wing; on that face the base of the veins are densely covered with erect long scaly hairs which extend conspicuously on nearly the whole length of R_4 and come there in contact with the curved tuft of the costa.

Abdomen with uniform brownish vestiture. *Hypopygium* of the usual *Pericoma* type (Fig. 42*I*); cercopods not quite twice as long as the tergum and carrying about 20 erect retinaculae (Fig. 22*J*), distributed on the apical 2/5 of their dorsum; basistyles short, and rounded; dististyles rather thin, gradually tapering and curved outwards; aedeagus symmetrical, penis moderately long with blunt apex and 2 rounded side lobes.

Female

Several specimens of that sex collected at the same time with the males described above undoubtedly belong to the same species in spite of the strong dimorphism in wing venation; similar dimorphism exists in *Ulomyia fuliginosa* and in *Telmatoscopus aberrans*, sp. nov.

Vestiture of the body completely brownish grey, paler than in the male. Flagellar segments provided with necks smaller than the bulb, the first 2 segments rather fusiform, last segment as in the male; no paired ascoids present but on each flagellar segment there is a round pore without trace of a sensory cone in it.

Palpi as in the male. Hairs of the thorax moderately dense, tarsi white. Wings (Fig. 42*K*) elongate oval, somewhat narrower than in the male, their apex placed at the tip of R_5, anterior fork distinctly before the posterior one and both much before the level of the extremity of *Cu* which is on the middle of the wing.

Wing covering paler than in the male; a small tuft of adpressed hairs at each of the forks; the rows of erect hairs on the usual veins, these ending near the tip of R_1, R_2, R_3, and *Cu* but much before and about at the same level on R_4, M_1, M_2, and M_3.

Subgenital plate as in Figure 42*L* with rather small lobes, ovipositor as usual.

Length of wing 2-1/3 mm.

Type, allotype, 4 ♂ and 3 ♀ paratypes: Narara, 3.xi.1921, along creek.

Other specimen: 1 ♀, Fitzroy Falls, 22-27.xi.1937.

A ♂ and a ♀ are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

TELMATOSCOPUS (NOTOTELMATOSCOPUS) VIDUATUS, sp. nov.

Fig. 43

A medium-sized species with uniformly dark covering on the body, legs, and wings; the latter without any tufts; the 2 forks at the same level much before the middle of the disc; tip of R_4 near the wing apex.

Male

Head with eyes nearly touching; a small tuft of blackish scaly hairs on the face and a recumbent one on the clypeus.

Antennae as long as the width of the wing disc, 16-segmented; 1st segment subcylindrical, over twice as long as broad, the 2nd spherical and those of the flagellum more or less amphora-shaped (Fig. 43*A*) the basal ones with relatively shorter necks, last segment with a somewhat club-shaped apiculus shorter than the basal bulb. Covering of the scape composed of black scales; verticils paler brown, not very regularly campanuliform. Ascoids present in pairs on segments 4-16; they assume the usual shape, their points of insertion being rather close to one another; besides these there are a rather large number of thinner ascoids nearly as long as the normal ones; they number about 25 on the median segments; they are inserted on the upper ½ of the bulb without apparent order in between the ordinary hairs or bristles of the verticils; on segment 3 (which is nearly ovoid with a small neck) they are more numerous and extend down more towards the base of the segment on its internal side.

Palpi (Fig. 43*B*) densely covered with black scales; 1st segment ½ as long as the 2nd, which is subequal to the 3rd; the 4th ½ as long again.

On the membrane between the thorax and the head there is on both sides, just below the shoulders, a small brown knob-like organ (Fig. 43*C*) which does not seem to be erectile as its very short base is very weak and membranous: the texture of this knob is fairly chitinous and its anterior face is provided with a large number of papillae. *Legs* with uniformly brown covering; fringe of mid and hind tibiae long.

Wing elongate-oval (Fig. 43*D*); apex well rounded and placed very slightly below the tip of R_4; the 2 forks nearly at the same level; that is, noticeably before the middle of the disc and well before the tip of *Cu*; origin of the stem of the anterior fork exactly at the apex of the 1st basal cell; the 2 basal cells subequal to each other.

Wing covering uniformly brown on the veins and the fringe; no distinct tufts are present on any part of the disc nor at the tip of the veins; on the under side the hairs at the base of the veins are somewhat more scaly. The rows of erect bristly hairs are present on all the longitudinal veins; they extend to the tip of R_1, R_2, and Cu; on R_3 they stop at a little distance from the tip of that vein but it is the longest of all the rows; on R_4 they stop a little before the level of the row on R_3; the rows on R_5 and M_4 stop at about the same level in front of the forks; the rows on M_2 and M_3 are of equal length and reach the level of the tip of M_4 whereas the row on M_1 extends distinctly over that level.

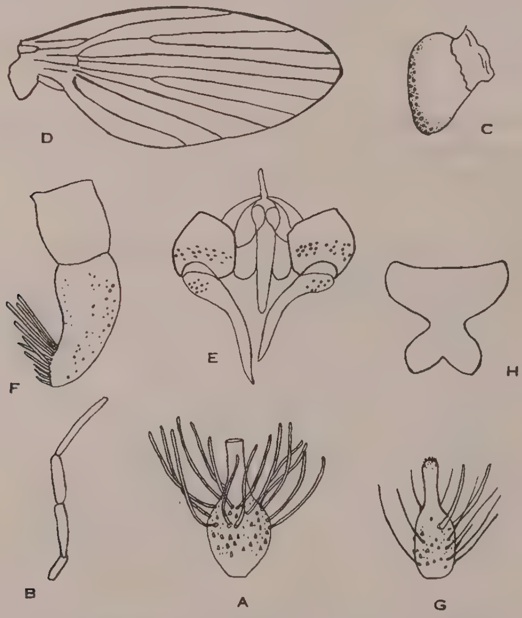

Fig. 43.—*Telmatoscopus viduatus*, sp. nov. *A*, flagellar segment; *B*, palp; *C*, allurement organ; *D*, venation; *E*, hypopygium; *F*, cercopod; *G*, terminal antennal segment of ♀; *H*, subgenital plate.

Hypopygium (Fig. 43*E*) small, coxites subspherical; forceps rather thin, not much incrassate at the base, their shaft gently curved outwards, apex acute; aedeagus with a moderately long central piece blunt at apex and flanked with 2 shorter lobes. Cercopods (Fig. 43*F*) small and thick, not quite twice as long as the 9th tergite which has a single slit-like pseudo-spiracular opening; apex of cercopods blunt and provided with about 15 retinaculae directed forwards, the proximal ones being noticeably longer than the distal ones.

Female

Similar to male, covering of head paler brown and less scaly also on the base of antenna and palpi; no black scales among the brown hairs on the anterior part of the mesonotum. Antennae somewhat shorter, the necks of the flagellar segments being relatively shorter; the normal ascoids are present in pairs on segments 4-16 (Fig. 43*G*), no thinner ascoids.

Subgenital plate with well-developed diverging lobes as in Figure 43*H*.

Type, 3 ♂, 1 ♀, paratype: Eaglehawk Neck, 4.xi.1922.

Allotype, 8 ♂, 2 ♀, paratype: Burnie, 27.x.1922, 31.i.1923, 21.x.1933. 1 ♂, National Park, Tasmania, 15.xii.1922. 2 ♂, Geeveston, 8.xii.1922. 1 ♀, Ferntree, 25.x.1921. 1 ♀, Mt. Farrel, 9.ii.1923.

Other specimens: 2 ♀, Ferntree, 25.x.1921.

Five paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

Telmatoscopus (Eutelmatoscopus) aberrans, sp. nov.

Fig. 44

A brownish black species with 3 dark tufts on the wing disc, venation differing according to sex, normal in the ♀ but in the male the base of R_3 has been switched over to R_4 with which it forms a fork.

Male

Head with moderately long brownish black covering not forming any conspicuous tuft. *Antennae* 1¾ times as long as the width of wing, 16-segmented; the 1st segment nearly 3 times as long as wide, the 2nd spherical; those of the flagellum bulbous with a distal neck. The 1st (Fig. 44*A*) is, however, somewhat different, its bulb not being so spherical and the transition between the bulb and the neck being more gradual; the relative length of the neck to the bulb goes on increasing gradually up to the 10th or 11th segment where it is almost twice as long as the bulb itself; last segment (Fig. 44*B*) with its apiculus somewhat longer than the bulb and pubescent. Scape covered with blackish scales not forming any tuft; verticils of flagellar segments brown, large, campanuliform; that of the 1st flagellar segment denser. On all flagellar segments, including the last one, there is a pair of very long ascoids, curved in spiral in opposite directions. *Palpi*: all segments covered with black scaly hairs (Fig. 44*C*).

Thorax covered with dark, erect, rather long but moderately dense hairs on the mesonotum, a rather long tuft on the anepisternites, and a fan of hairs on the hypotergites; there are no display organs on the thorax. *Legs* with uniformly brown covering; the fringe of the hind tibiae very conspicuous.

Wings lanceolate (Fig. 44*D*) with the apex placed between R_4 and R_5; the 2 forks on the disc are separated by a single vein as in *Trichomyia* but this is not due to the absence of R_4 or R_5 but to the fact that the base of R_3 has been switched over and fused to R_4 (a similar process has occurred in *Psychoda aberrans* Tonn. but here the vein of R_3 does not quite come in contact with R_4 and this peculiar venation is found in the female, the only sex known so far); on R_2 a little further than the fork thus formed, there is a small swelling at the spot where the little tuft of hairs is present and where the normal fork of $R_2 + R_3$ should have been; both forks are placed at the same level, a little before the middle of the wing and in front of the extremity of *Cu*; the origin of R_2 is to be found on R_1 at a noticeable distance from the basal cell; *Cu* has its origin at the fork of $M_3 + M_4$ and is rather incrassate a little after its base.

Covering of the wing a rich blackish brown; the hairs forming the adpressed divaricate tufts at the end of the veins R_1, R_2, R_3, M_2, M_3, M_4, and *Cu* are white at the tip; on the middle of the disc there are 2 tufts of erect black hairs on R_2 and M_2 a little way past the forks; a 3rd similar tuft is found on *Cu* a little before the tip of that vein. The rows of erect hairs are present on all the longitudinal veins except R_1, R_5, and M_4 and they all stop at the level of the little, partly white tufts; the fringe is uniformly dark and rather long on the posterior border.

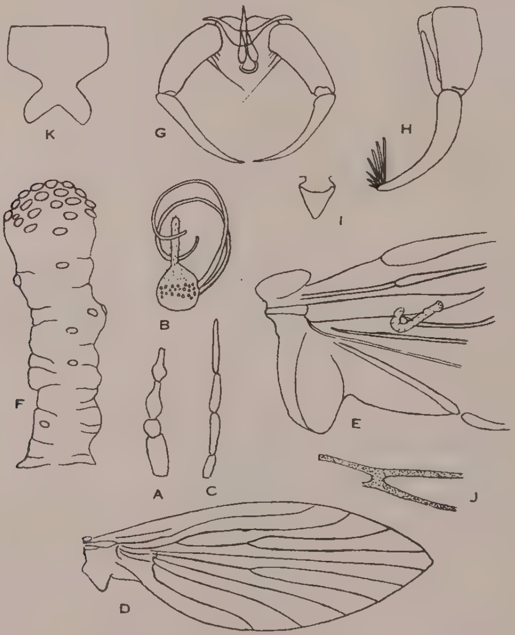

Fig. 44.—*Telmatoscopus aberrans*, sp. nov. *A*, base of antenna; *B*, terminal segment of antenna; *C*, palp; *D*, venation; *E*, wing base showing patagium; *F*, patagium; *G*, hypopygium; *H*, cercopod; *I*, anal flap; *J*, junction of R_2 and R_3 in ♀ wing; *K*, subgenital plate.

A very peculiar character of this species is the presence of a patagium underneath and on the base of the wings (Fig. 44*E*); it is placed on R_1 and is normally straight and perpendicular to the wing membrane, not curved as shown in the drawing made from a flattened preparation. This patagium is cylindrical and about as long as the stump of R_1 from that spot to the base of the wing; it carries a number of papillae distributed here and there along its shaft (Fig. 44*F*) but they are more closely packed at the tip of the organ.

Abdomen with erect brown covering; *hypopygium* of the usual type, basistyles elongate (Fig. 44*G*), curved, with a few sensory setae at the base inside, dististyle not bulbous at the base, elongate, falcate, and acute, penis small and rounded; cercopods about twice as long as the tergum itself, not swollen at the base, and with about 9 retinaculae (Fig. 44*H*).

Female

Antennae distinctly shorter than in the male, the neck of the flagellar segments not longer than the bulb, ascoids absent on segments 15 and 16, which carry half a dozen sensory cones; venation normal, that is, the base of R_3 not detached from R_2 and forming a fork with it, which is placed a little after the fork of M; however, the base of R_3 is somewhat loosely connected with R_2 (Fig. 44*J*). *Subgenital plate* as shown in Figure 44*K*, with 2 rather well-marked lobes diverging at right angles from each other; oviscape little curved and of moderate length.

This species was found round a muddy patch in a bush track; at first only males were secured and a visit was made daily at the same spot until some females were obtained; there can be little doubt that the 2 sexes belong to the same species.

Type, allotype, 10 ♂, 1 ♀ paratype: Eaglehawk Neck, 17-22.x.1922.

Paratypes: 1 ♂, Geeveston, 7.xii.1921. 1 ♂, 1 ♀, no locality. 1 ♀, Mt. Farrel, 9.ii.1923.

Other specimens:* 3 ♂, 1 ♀, Lee Spring, 13.xi.1938. 3 ♂, 1 ♀, Blundells, 13.xi.1938.

Two ♂, 1 ♀ specimens are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

TELMATOSCOPUS (EUTELMATOSCOPUS) SPIRALIFER, sp. nov.

Fig. 45

A uniformly brownish medium-size species without markings or tufts on the wings; anterior fork a little past the posterior one and placed at or a little before the level of the tip of *Cu;* tip of R_5 subapical.

Length of wing 2 mm.

Male

Covering of body and all the appendages uniformly brownish ochraceous. Tuft on face small; eyes almost touching, the eye bridges 4 facets wide. *Antennae* much longer than the width of wing disc; 1st segment nearly twice as long as wide (Fig. 45*A*); the 2nd spherical, the following ones with a basal bulb and a distal neck which is little developed in the basal segments but increases gradually in the more distal segments (Fig. 45*B*) so as to be at least equal in length to the basal bulb which is eccentric (that is, bulging on 1 side); last segment subspherical with a long subcylindrical apiculus (Fig. 45*C*).

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* In the collection Tonnoir has placed certain specimens under a label *T. pseudaberrans.* There is, however, no manuscript description of this species and I am unable myself to recognize any significant difference between these 2 segregates. The typed manuscript notes referring to *T. aberrans* have the note "and *T. pseudaberrans*" added in pencil on the heading, and it is probable that he intended uniting the 2 and regarding them all as *T. aberrans.* I have adopted this view; all the specimens listed as "other specimens" are ones originally under his *T. pseudaberrans* label. (G.H.S.)

Segments 4-15 provided with a pair of long curled ascoids whose points of insertion are not far from each other. *Palpi* (Fig. 45*D*) with a short 1st segment equal to 3/5 of the 2nd which is subequal to the 3rd; 4th thin and twice as long as the 3rd.

Thorax without trace of display organs. *Wings* lanceolate, apex subacute and placed just above the tip of R_5 (Fig. 45*E*); anterior fork a little past the posterior one (sometimes almost at the same level but never before); both forks distinctly before the tip of *Cu* or sometimes the anterior one almost at the same level with the tip of *Cu*. Origin of the stem of $R_2 + R_3$ placed on R_4 at a distance from the apex of the 1st basal cell not exceeding the width of that cell at the apex.

Wing covering including the fringe, of uniform brownish coloration without darker tufts; rows of bristly hairs absent on R_1, R_5, and M_4; on R_2, R_3, M_3, and *Cu* they reach the tip of these veins; on R_4, M_1, and M_2 they extend only to an imaginary line uniting the tip of R_2 with that of M_3.

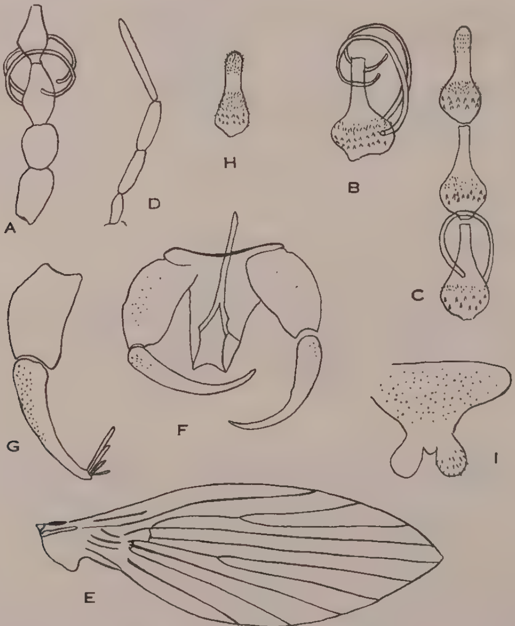

Fig. 45.—*Telmatoscopus spiralifer*, sp. nov. *A*, base of antenna; *B*, distal segment of antenna; *C*, tip of antenna; *D*, palp; *E*, venation; *F*, hypopygium; *G*, cercocop; *H*, tip of ♀ antenna; *I*, subgenital plate.

Hypopygium (Fig. 45*F*); coxites well developed, more or less obconical, styles long, falcate, regularly and gradually tapering, and curved to a fine point, its distal ½ not so infuscated as the base. Aedeagus of simple structure without apparent parameres; cercopods (Fig. 45*G*) not quite twice as long as the 9th tergite, regularly curved and tapering and carrying 4-5 retinaculae at the apex, the shortest being more distal; the 2 pseudostigmatical openings fused in 1.

Female

Similar to male, antennae shorter, the distal neck (Fig. 45*H*) of the flagellar segments not being so much developed; ascoids short and of normal shape. *Subgenital plate* as in Figure 45*I*, the distal lobes presenting themselves as lateral flaps inserted on the plate.

Type, allotype, 3 ♂, 3 ♀, paratypes: Wentworth Falls, 18.xi.1921.

Paratypes: 1 ♂, Macquarie Pass, 23.xii.1934. 2 ♂, 6 ♀, Mt. Wilson, 19.xi.1921. 2 ♂, Waterfall, Nov. 1921. 2 ♂, 3 ♀, Kangaroo Valley, 11.ii.1935. 1 ♂, 1 ♀, Fritzroy Falls, 22-27.xi.1937.

Other specimens: 1 ♀, Brown Mt., 25.ii.1939. 1, genitalia missing, same locality. 2, genitalia missing, Macquarie Pass, 2.x.1938.

Three paratypes are in the Division of Entomology Museum, C.S.I.R.O., Canberra.

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APPENDIX I

LIST OF LOCALITIES

Australian Capital Territory

Black Mt.
Blundells
Canberra
Shannon Creek
Lee Spring

New South Wales

Belmore Falls
Brown Mt.
Clyde Mt.
Eastwood
Eurobodalla
Fitzroy Falls
Jenolan Caves
Kangaroo Valley
Killara
Macquarie Pass
Mittagong
Mt. Kembla
Mt. Kosciusko
Mt. Tilba Tilba
Mt. Wilson
Narara
Narooma
Palm Beach
Stanwell Park
Tilba Tilba
Waterfall
Wentworth Falls
Wyndham (southern N.S.W.)
Yass

Queensland

Eidsvold
Townsville
Yeerongpilly

Tasmania

Advent Bay
Burnie
Cradle Valley
Devonport
Eaglehawk Neck
Ferntree
Geeveston
Harz Mt.
Hobart
King River
Launceston
Maria I.
Mt. Farrel
Mt. Field
Mt. Hicks
Mt. Wellington
St. Patrick's River
Strahan
Weldboro Pass

Victoria

Ferntree Gully
Sassafras
Snowy River

Western Australia

Bridgetown
Broomhill
Crawley
Fremantle
Katanning
Nomans Lake
Pemberton

APPENDIX II

TYPE LOCALITIES OF AUSTRALIAN PSYCHODIDAE

Unless stated otherwise, the type specimen is located in the collections of the School of Public Health and Tropical Medicine, Sydney.

Notiocharis dimorpha, sp. nov. Eaglehawk Neck, Tas.
N. pallida, sp. nov. Narara, N.S.W.
Pericoma confusa, sp. nov. Wentworth Falls, N.S.W.
P. pseudoalbipes, sp. nov. Wyndham, southern N.S.W.
P. uniformata, sp. nov. King River, Tas.
P. punctulata, sp. nov. Sassafras, Vic.
P. illustrata, sp. nov. Mt. Wellington, Tas.
P. subillustrata, sp. nov. Harz Mt., Tas.
P. tasmaniae, sp. nov. Maria I., Tas.
P. albipes, sp. nov. Narara, N.S.W.
P. rotundipennis, sp. nov. Narooma, N.S.W.
P. intricatoria, sp. nov. Burnie, Tas.
P. bancrofti Tonnoir 1920. Burpengary, Queensland. Type in the British Museum, London.
Psychoda pseudoalternata Williams 1943. Canberra, A.C.T. Type in the Bernice P. Bishop Museum, Honolulu.
P. dennesi, sp. nov. Townsville, Queensland.
P. aenigmatica, sp. nov. Hobart, Tas.
P. unimaculata, sp. nov. Eaglehawk Neck, Tas.
P. irrorata, sp. nov. Burnie, Tas.

P. truncata, sp. nov. Ferntree Gully, Vic.
P. subpennata, sp. nov. Kangaroo Valley, N.S.W.
P. squamata, sp. nov. Cradle Valley, Tas.
P. arcuata, sp. nov. Ferntree, Tas.
P. squamipleuris, sp. nov. Black Mt., A.C.T.
P. apennata, sp. nov. Burnie, Tas.
P. ypsylon, sp. nov. Ferntree, Tas.
Trichopsychoda montana, sp. nov. Mt. Wilson, N.S.W.
Telmatoscopus variegatus, sp. nov. Mt. Wellington, Tas.
T. subvariegatus, sp. nov. Mt. Wilson, N.S.W.
T. poncianicolus, sp. nov. Townsville, Queensland.
T. townsvillensis (Taylor) 1915. Townsville, Queensland. Presumed type in the School of Public Health and Tropical Medicine, University of Sydney.
T. festivus, sp. nov. Macquarie Pass, N.S.W.
T. gregsoni, sp. nov. Mt. Wilson, N.S.W.
T. crassepalpis, sp. nov. Pemberton, W.A.
T. dimorphus, sp. nov. Narara, N.S.W.
T. obscurus, sp. nov. National Park, Queensland.
T. viduatus, sp. nov. Eaglehawk Neck, Tas.
T. nicholsoni, sp. nov. National Park, Tas.
T. neglectus, sp. nov. Kangaroo Valley, N.S.W.
T. norrisi, sp. nov. Pemberton, W.A.
T. aberrans, sp. nov. Eaglehawk Neck, Tas.
T. confusus, sp. nov. Eaglehawk Neck, Tas.
T. spiralifer, sp. nov. Wentworth Falls, N.S.W.
T. fordi, sp. nov. Wentworth Falls, N.S.W.
Atrichobrunettia alternata, sp. nov. National Park, Tas.
A. subalternata, sp. nov. Pemberton, W.A.

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N. pallida, sp. nov. 366
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P. confusa, sp. nov. 367
P. illustrata, sp. nov. 422
P. intricatoria, sp. nov. 430
P. pseudoalbipes, sp. nov. 370
P. punctulata, sp. nov. 421
P. rotundipennis, sp. nov. 429
P. subillustrata, sp. nov. 424
P. tasmaniae, sp. nov. 425
P. uniformata, sp. nov. 419
Genus *Phlebotomus* 360
Genus *Psychoda*
P. aenigmatica, sp. nov. 376
P. alternata Say 361
P. apennata, sp. nov. 388
P. arcuata, sp. nov. 385
P. cinerea Banks 361
P. dennesi, sp. nov. 375
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P. spatulata Sat. 372
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P. subpennata, sp. nov. 382
P. truncata, sp. nov. 381
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T. nicholsoni, sp. nov. 404
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A REVIEW OF AUSTRALIAN APIOCERIDAE (DIPTERA)

By S. J. PARAMONOV*

[*Manuscript received June* 24, 1953]

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Summary

No previous review of Australian Apioceridae has been written, and prior to this one only 15 *Apiocera*, and 2 *Neorhaphiomydas* species were known. In the review of the geographical distribution of this family for the whole world Cazier (1941) accepted the Apioceridae as occupying only the southern part of Australia.

This review, based on the study of all available material from the Australian Museums, adds 49 new *Apiocera* species, and 4 new *Neorhaphiomydas* species, so that the fauna of Australia now consists of 64 *Apiocera* and 6 *Neorhaphiomydas* species, making it the richest in the whole world. The Australian continent is occupied by numerous representatives of this family, many not yet described, distributed from the sea-shores to the mountain summits; especially rich is Western Australia, where studies to date have only touched on the fauna.

A comprehensive key for the identification of both males and females is included in this review.

In the short introduction, the basic data of morphology, bionomics, and geographical distribution of the family has been given. A list of the most important literature for the guidance of students has also been added.

I. INTRODUCTION

Our knowledge of the Australian Apioceridae is very meagre, and the study of their systematics, bionomics, and distribution only in its early stages. This

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* Division of Entomology, C.S.I.R.O., Canberra, A.C.T.

is demonstrated very clearly by the number of new species described in this paper; two species of *Neorhaphiomydas* were previously known, and four new species are described, whilst 15 species of *Apiocera* were previously known, and 49 new species are described. As further illustration of the slow development of our knowledge of this interesting family may be cited the fact that nothing was known of the life history of any species until 1947, when Miss K. English published an account of the immature stages of *Apiocera maritima* Hardy. As recently as 1941 Cazier published a map, based on records in the literature, indicating that the family Apioceridae occurred only in the southern half of Australia, whereas it will be seen from the records of distribution published in this paper that they are well represented throughout the continent.

As yet only a few specimens have been obtained from the Northern Territory and Queensland, and more intensive collecting will probably bring to light many more species. There are references in the literature to Apioceridae occurring in Tasmania, which Hardy (1933) considered erroneous because no specimens are known from there. The present author considers that this is probably due to the fact that insufficient collecting has been done in Tasmania, as Apioceridae occur on the Australian mainland at elevations of 6000 ft, where climatic conditions resemble those of Tasmania, and a strong similarity is to be noted to that fauna.

The family is not represented in New Zealand, being in the author's opinion extinct as a result of the very cold climate in the past.

The Australian Apioceridae bear a close relationship to those of South America, and to a less extent, of South Africa. The North American species are less closely related. The following is a synopsis of the world distribution of the family (Fig. 1):

Genus	No. of Species	Found In
Megascelus Philip.	1	Chile
Neorhaphiomydas Norr.	6	Western Australia
Rhaphiomydas O.S.	12	California and Mexico
Apiocera Westw.	2	South Africa
	20	North America
	2	Chile
	64	Australia
	1	Borneo (Hermann 1909)
	1	Ceylon (Verrall 1909)

The isolated distribution of the genera shows that this family is probably very old, existing genera probably being the remnants of a more extensive fauna, but no palaeontological evidence is yet available in support of this view. The existing Australian fauna is by far the richest and most diversified, as is evident from the above synopsis.

II. Historical Review

The first species belonging to the family Apioceridae was described by Wiedemann in 1830, and was placed in the Asilidae (*Laphria brevicornis* Wied.), but the genus *Apiocera* (apios, a pear; cerata, a horn) was established by Westwood in 1835, with *Apiocera asilica* Westw. as the generotype.

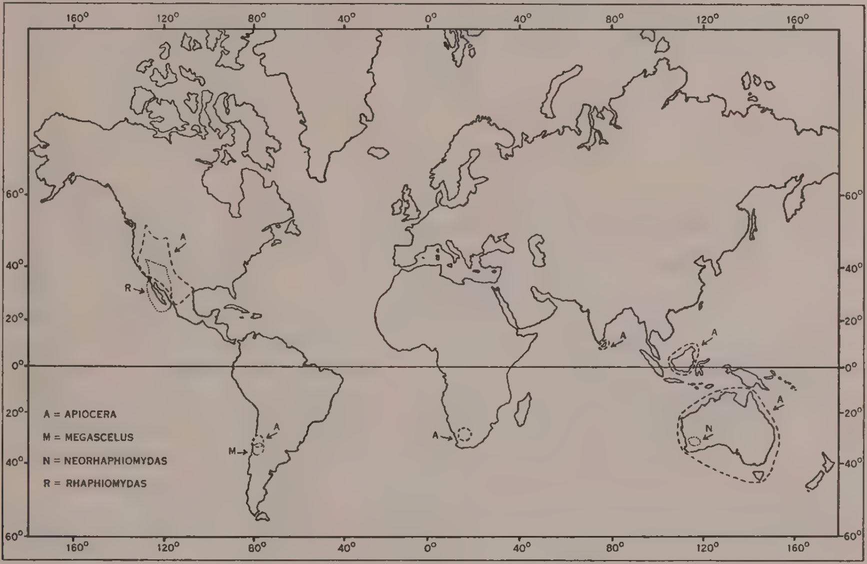

Fig. 1.—World distribution of Apioceridae.

Macquart (1838), basing his opinion only on Wiedemann's description, erected a new genus, *Tapinocera* Macq., with *Laphria brevicornis* Wied. as the type species. In 1847 Macquart, studying an *Apiocera* species, did not recognize his own genus *Tapinocera*, and described a new genus, *Pomacera* Macq. For this genus he erected a family Pomaceridae. *Rhipidosyrma* Hermann (1909) is also a synonym of *Apiocera*.

Bigot (1857, see Cazier 1941) established the family Apioceridae.

Philippi (1865) described a second genus, *Megascelus*, regarding it as belonging to the Mydaidae. Its true position, however, was not recognized until 1909 by Hermann, whose statement was overlooked by later authors until Cazier again assigned the genus to its correct family position in 1941 (see also Paramonov 1948; Carrera and d'Andretta 1948).

Osten-Sacken established the third genus, *Rhaphiomydas*, in 1874. The genus *Apomydas* described by Coquillett in 1892 is a synonym of this.

Norris (1936) described the fourth genus, *Neorhaphiomidas.*

Coquillett in 1910 (see Cazier 1941) erroneously designated *Apiocera fuscicollis* Westw. as the generotype. However, the species *A. asilica* Westw. has priority, being described as "sp. 1" by Westwood, whereas *A. fuscicollis* was accepted by Westwood with some doubt as a species distinct from *A. asilica* as indicated by the words, "An varietas praecedentis?" There is no justification for the view of Hardy (1933) that *A. fuscicollis* Westw. 1835 is a synonym of *A. brevicornis* (Wied.) 1830, as, since the description of *Laphria brevicornis* Wied. no further information has been published about the type. Even if these species were identical, which cannot be proved because the type of *A. fuscicollis* Westw. in the British Museum is unrecognizable,* *Apiocera asilica* Westw. would still remain the generotype, because Wiedemann's species was not mentioned by Westwood in erecting the genus *Apiocera*.

III. TERMINOLOGY

Brues and Melander (1932) altered the name of the family from Apioceridae to Apioceratidae, without advancing reasons for the change. In this they have been followed by a number of subsequent authors, who, presumably have considered that the change was in accordance with "Latin rules." It is true that we accept Latin as an international language, with the rules of its pronunciation and grammar, but it is also true that no Latin grammar universally accepted by philologists exists. Latin is not a living language, but it is only, so to speak, "conventional" Latin, including such letters absolutely foreign to the classic language as, for example, "k" and "y," and avoiding the use of signs of length on vowels, etc. As our Latin is even more debased than the so called "kitchen Latin," the strict use of rules of Latin grammar is pure pedantry.

It is useful to remember that the radices of "apion" and "ceratos" are not of Latin but of Greek origin. In such cases the use of rules of Greek grammar† or the Latin rules in regard to Greek radices is quite evidently nonsense.

For instance, if the strict use of Latin grammar is to be accepted we must change such common names as *Nematocera* to *Nematocerata, Rhopalocera* to *Rhopalocerata*, etc. This unnecessary complication of nomenclature would be a retrograde step, only serving to retard the progress of the science. In this case, in accordance with the International Rules it is simply necessary to take the radix "Apiocer-" and to add the ending "idae," resulting in the more convenient form Apioceridae for this family.

The greater number of authors after much discussion now accept the orthography *-mydas,* but not *midas*; it is therefore logical to amend all derivative forms in *Apomydas, Rhaphiomydas, Neorhaphiomydas* to give conformity.

As "type," the author regards the most characteristic specimen from the series of specimens upon which the description of the species is based. When both sexes are available for description, a male is always accepted as the type, unless there are special reasons for choosing a female. Each of the remaining specimens in the series used is designated "paratype," which is the equivalent of the term "cotype" as used in previous papers.

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* According to the staff of the British Museum.

† In reference to Latin words.

All type specimens of species described by Mr. K. R. Norris are in the collection of Western Australian Museum, Perth.

IV. Bionomics

Apioceridae in Australia occupy an extremely wide range of habitats. Some species occur on sea beaches and sand dunes, others are to be found in arid deserts and some have been taken at altitudes of about 6000 ft in eucalypt forest growing along streams. Many intermediate types of habitat are also occupied.

Most frequently the flies are to be found resting on the ground, but occasionally they rest on leaves and twigs. Regarding the feeding habits of the adult flies, Norris (1936) wrote: "To judge from the nature of the proboscis the flies are essentially flower-feeders. The writer has not seen any record of the species of *Apiocera* being taken at flowers, and of the species which he has collected in the field, only one was directly observed visiting flowers. Indirect evidence of the feeding habits is readily obtained by an inspection of the proboscis and palpi, which in dried specimens can be seen, even after years of preservation, to be sticky with honey or coated with pollen." This has since been confirmed by the present author's observations and those of his colleagues. Figure 2 is a photograph from nature of a specimen of *Apiocera hardyi*, sp. nov. visiting a flower of *Angophora cordifolia*. This photograph was taken by Dr. A. J. Nicholson, who kindly consented to its publication.

Examination of most of the important collections in Australia, together with field observation, shows that the majority of the species are most common in the late summer.

An observation on oviposition was given by Norris (1936) and an account of the life history of *Apiocera maritima* Hardy by English (1947).

V. Systematics

Characteristics of the Family

Rather large or medium-sized flies, with elongated body, similar to the robber-flies (Asilidae). They are generally dull-coloured, varying in degree of vestiture from almost bare to hairy, the latter being more rare.

Head comparatively large, but flattened anteriorly, always dichoptic, without bristles except for numerous strong occipitals. Eyes large, always bare, more widely separated in female than in male; facets of equal size. Ocelli very well developed, 3. Antennae short, very rarely longer than length of head, inserted below the middle of head, 3-jointed. First antennal joint a little elongated, 2nd globular, 3rd as a rule pear-shaped or oval, ending in a very short, stout, jointed style; basal joints with rather strong bristles. Palpi 1- or 2-jointed, apical always broader than the basal, and spatulate. Face very short, with few hairs. Mouth cavity very large, often reaching nearly to the base of antennae, cheeks always very narrow. Proboscis very often as long as head, or rarely 2-3 times longer, with fleshy labella.

Thorax stoutly built, prothorax often with a circlet of bristles above. Macrochaetae as a rule well developed, but may be weak or absent. When present they are humeral, notopleural (a row), supra-alar, postalar, and some dorsocentral (prescutellars). Pleurae without bristles. Mesopleurae haired, but they may be nearly bare at anterior spiracle. Scutellum large, concealing the metanotum; with 4 or 6 bristles which are comparatively weak if they are more numerous.

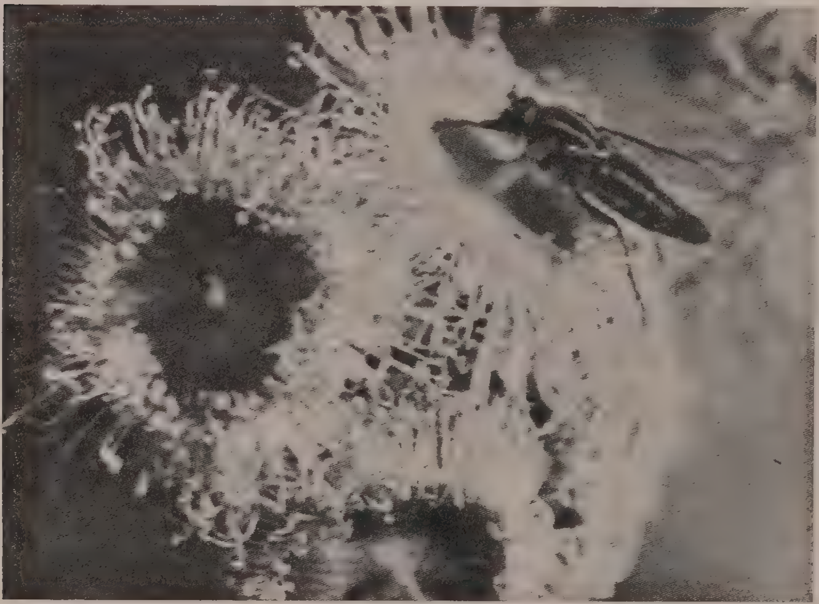

Fig. 2.—*Apiocera hardyi*, sp. nov. on the flowers of *Angophora cordifolia*. (Photo: Dr. A. J. Nicholson.)

Wings mostly very short in proportion to the body, usually with well-developed alula, but it may be reduced to a size smaller than a "triangular cell" (Fig. 3). Usually all veins are well developed, but a number of species have the ambient vein absent or all veins running to the apical part of wing are weak, nearly obsolete, in 1 species (r_4) quite absent.

Wings mostly hyaline, very rarely with some markings or slightly coloured. The venation is very characteristic. The veins r_4, r_5, m_1 (and in *Rhaphiomydas, Megascelus* m_2) curve forwards and end before the apex of wing; r_4 reaching the anterior border in common stem with r_{2+3}, but not separately (similar to Mydaidae). Subcostal vein very long, beyond ½ way to the tip of wing; r_1 (accepting r_{2+3}, r_4, and somtimes r_5, m_1, or even m_2) extending to near apex.

Four or (normally) 5 posterior cells. Discal cell always present; 4th posterior cell (subdiscal in author's terminology) sometimes isolated because of lack of vein m_{3+4}.

Two basal cells (*M* and *R*) and anal cell always very long, occupying at least 1/3 of whole wing. Axillary cell always well developed. Halteres comparatively small and inconspicuous.

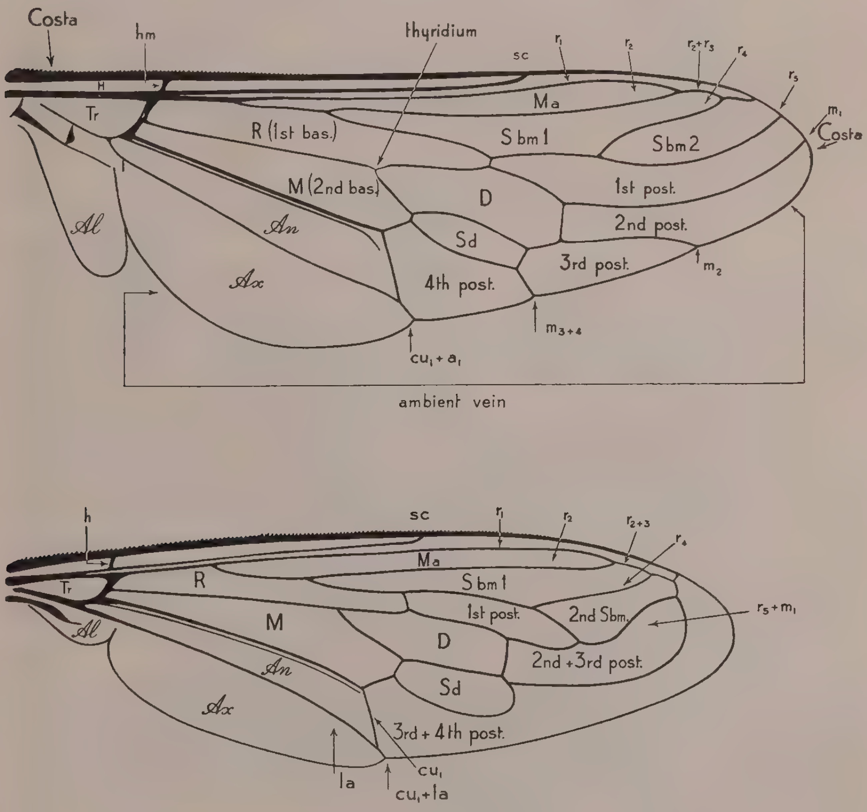

Fig. 3.—Wing venation.

Legs long, but not strong, with numerous bristles on tibiae and usually on femora, but sometimes the bristles are sparse on anterior femora. Tibiae with long apical spurs; 4 basal tarsal joints with apical circlets of bristles. Two well-developed pulvilli; empodium absent, or represented by a bristle. Claws rather long and strongly curved.

Abdomen elongated, conical or elongated oval, usually very broad at base and tapering distally. Genitalia in male always well developed, plainly visible, sometimes very large, swollen, having some value for identification of species;

in female with a circlet of characteristic hooks, the last segment of abdomen usually with erect hairs, much more rarely the 2 or even last 3 segments are covered with erect hairs.

KEY TO GENERA OF THE FAMILY APIOCERIDAE

1. Cell R_5 (between the veins r_5 and m_1; its base is the vein r-m) closed very far from the apex of wing; isolated from the apex of wings by cell M_1, which is also closed and ends at the common stem of the radial veins at anterior border of wing. Whole complex of radial veins and veins m_1 and m_2 terminate in a common vein. Vein m_{3+4} absent or present. Mesonotum and scutellum without bristles 2

Cells R_5 and M_1 open and both reaching the anterior border of wing. The complex of radial veins has at least 2 veins terminating on anterior border of wing. Mesonotum and scutellum always with very strong black or (rarely) white bristles 3

2 (1). First 2 joints of antennae equal, at least 3 times broader than long. Third joint very large, egg-like, 3 times as long as the 2 basal joints together. Chile. . . . . .
*Megascelus** Philippi

First joint of antennae always longer than broad, at least twice as long as the 2nd. Western Australia . . . . *Neorhaphiomydas* Norr.

3 (1). Vein m_2 always present, terminating in anterior border of wing, running parallel to the hind border. Palpi 1-segmented. Large conical swelling present on lateral lobes of postnotum. North America (western part) . . . .
Rhaphiomydas Ost. Sack. (= *Apomidas* Coq.)

Vein m_2 terminating in the hind border of wing; if it is weak, there are traces showing the direction in which it runs. Conical swelling on lateral lobes of postnotum absent. Australia, Ceylon, North Borneo, South Africa, South and North America. . . . . . *Apiocera* Westw. (= *Tapinocera* Macq., *Pomacera* Macq., *Anypenus* Philip., and *Rhipidosyrma* Herm.)

Genus APIOCERA Westwood

Apiocera Westwood, 1835, Phil. Mag. **6**: 449.

Generotype *A. asilica*.

The characteristics of the genus coincide in most respects with those given for the family. The genus differs from *Neorhaphiomydas* in the conical shape of the abdomen, tapering to the apex (in *Neorhaphiomydas* the abdomen is broadly rounded at apex), and in wing venation (Fig. 3), and also in the segmentation of the palpi.

The 2 genera probably represent 2 different branches of the family (subfamilies) in the past. The family is apparently in declination and we have only isolated members of it.

KEY TO AUSTRALIAN SPECIES OF THE GENUS APIOCERA

1. Black hair or bristles absent on whole body (only in *A. pallida* some brown bristles may be present on mesonotum or legs). Ambient vein on hind margin or wing absent. Vein m_{3+4} absent, therefore the subdiscal cell is isolated. Veins

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* *Dolichogaster* Macq. is not a synonym of *Megascelus*, it is a mydaid form, while *Megascelus* is a true apiocerid form (Paramonov 1948).

on apical ½ of wing very weak, all veins yellow. Alula always much larger than triangular cell. Found on sand dunes on sea-shore (*A. maritima* group)..2*

Black hairs or bristles always present on body. If ambient vein and vein m_{3+4} absent, alula smaller than or nearly as large as triangular cell..............4

2 (1). Upper branch of 3rd longitudinal vein (r_4) completely lacking, a character present only in this species and which separates it from all other apiocerids. New South Wales, Queensland........................2. *A. excepta*, sp. nov. ♂, ♀

Vein r_4 always well developed...3

3 (2). Cross vein *r-m* before the middle of discal cell. Shortly haired species. Face and antennae nearly bare. Body (if not greasy) with pure white or slightly yellowish dust. New South Wales, Queensland....1. *A. maritima* Hardy ♂, ♀

Cross vein *r-m* beyond the middle of discal cell. Very long-haired species (especially on sides of thorax). Face haired. Hairs pure white, but mesonotum with stripes of brownish dust. Western Australia........3. *A. pallida* Norr. ♂, ♀

4 (1). Alula smaller than triangular cell at base of wing or at most as large as it. Ambient vein and m_{3+4} absent (exception *A. minor*). Vertex in male at least 1/3 the width of head (*A. minor* group)..................................5

Alula always larger than triangular cell at base of wing....................11

5 (4). Ambient vein and vein m_{3+4} absent.................................6

Ambient vein present from apex of wing to apex of anal cell. Subdiscal cell touching the lower basal cell, rather long, usually connected with hind margin by vein m_{3+4}. Bristles on mesonotum and scutellum extremely long. Alula nearly as broad as humeral cell, a character distinguishing this species (and *A. newmani*) from all *Apiocera* species. Length of body 12.5 mm. Western Australia......
4. *A. minor* Norr. ♂, ♀

6 (5). Subdiscal cell touching lower basal cell, longer than vein which closes anal cell. Proboscis extremely long, 3-4 times longer than the head; labella as long as the 1st antennal joint, only a little broader than the remainder of proboscis. Palpi and antennae also extremely long. Third antennal joint very elongated, at least as long as 2 basal joints combined. Abdomen with longitudinal greyish striping. Western Australia.........................7. *A. newmani* Norr. ♂, ♀

Subdiscal cell not touching lower basal cell, shorter than or as long as vein which closes anal cell. Proboscis, palpi, and antennae long, but not as in *A. newmani*. Abdomen without longitudinal striping.............................7

7 (6). Third antennal joint more or less pear-like, shorter than 2 basal joints combined..8

Third antennal joint conical, broader, and twice as long as 2 basal joints combined. This species belongs to *A. minor* group, but its alula is slightly larger than basal triangular cell. It is mentioned also in another part of this key. New South Wales.............................31. *A. latifrons*, sp. nov. † ♂, ♀

8 (7). Females. (Only female of *A. australis* is described, females of *A. mackerrasi*, sp. nov. and *A. vespera*, sp. nov. unknown). Western Australia (see description)....
6. *A. australis*, sp. nov. ♀

Males...9

9 (8). Vertex distinctly broader than 1/3 of head width, nearly 3 times larger than the ocellar triangle. Hairs on face, under side, and head, on anterior coxae, and sides of thorax pure white. Brown median stripe on mesonotum broad, not

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* Excluded from this alternative is a species with yellow ground colour, of the whole body, antennae, and legs, in which the vein r_5 at apex sharply approaches the apex of r_4, but does not run nearly parallel, and mesopleurae are quite bare (*A. omniflava*, sp. nov.).

† This species is included here also because the alula is not much bigger than triangular cell and it can be confused with this group.

divided by a narrow greyish stripe. Knob of halteres brown. Queensland......
5. *A. mackerrasi,* sp. nov. ♂

Vertex distinctly narrower than 1/3 of head or as broad as it. Halteres yellow....10

10 (9). Ocellar triangle twice as broad as distance between eye and posterior ocellus. Median brown stripe on mesonotum divided by a central greyish stripe, which is nearly 1/3 of the above-mentioned stripe. Hind margin of 1st to 4th tergites very distinctly bordered with greyish. Palpi mostly black-haired. Western Australia..............................8. *A. vespera;* sp. nov. ♂

Vertex about 3 times broader than ocellar triangle. Mesonotum without well-marked striping. Hind margin of 2nd, 3rd, and 4th tergites with 2 triangular greyish spots (no cross bands). Palpi and proboscis extremely long, as in *A. newmani.* Victoria, South Australia............6. *A. australis,* sp. nov. ♂

11. (4). Mesopleurae on anterior part quite bare, if there are some hairs they are poorly represented or absent on remainder of the sides of thorax. In these groups the abdomen very often lacks the triangular greyish markings..............12

Mesopleurae on anterior part (behind the anterior spiracle and above anterior coxae) always densely and long-haired (as on whole surface). Abdomen as a rule with triangular greyish markings..............................25

12 (11). Subdiscal cell (M_3) nearly equal to discal; veins which close these cells disposed nearly on a straight line or running in the same direction. Wings always yellowish or darkish suffused. Large part of tergites yellow, mostly shining (if dark, palpi blackish). Large species. Face well developed, margins of mouth cavity protruding. Under side of thorax mostly shining deep black. (*A. deforma* group) 13

Subdiscal cell as a rule distinctly shorter than discal cell. Veins which close discal and subdiscal cells do not form a straight line or run in the same direction. Wings hyaline, without well-marked suffusion. Tergites without large yellow spots. Palpi always whitish or yellowish, never blackish. Face very short, whole surface to base of antennae occupied by mouth cavity, its margins sunken. Under side of thorax not shining.................................17

13 (12). Apical joint of palpi very broad, egg-like, 3 times broader than basal joint, and a little broader than proboscis. Bristles on occiput yellow. Ground colour of tergites and sternites mostly yellow or orange-reddish..................16

Apical joint of palpi very long, narrow, at most twice as broad at apex as at base, and nearly as broad as proboscis.................................14

14 (13). Ground colour of tergites black. Sides of mesonotum with very distinct whitish longitudinal stripe of dusting. Length of body 23 mm. Western Australia....
10. *A. deforma* Norr. ♂, ♀

Very similar to *A. deforma,* but having in both sexes very distinct yellow pulverulence on 3 basal tergites, which can mask ground black colour. Mesonotum dark, with very well-developed white longitudinal stripe just below mesopleural and mesonotal suture. Mesonotum on anterior part in male with 2 well-developed white wedges, in female they are developed into 2 longitudinal stripes, nearly reaching scutellum. Western Australia...................
15. *A. helenae,* sp. nov. ♂, ♀

Ground colour of tergites bright orange, shining, as if polished. Sides of mesonotum with a very indistinct whitish stripe of dusting. Genitalia of males deep black or reddish, shining..15

15 (14). Antennae reddish. Second, 3rd, and 4th tergites with very broad yellow, shining cross band on the apical ½. Fifth tergite and the remainder of abdomen red, shining (female unknown). Western Australia....13. *A. elegans,* sp. nov. ♂

Antennae dark. At least 4 tergites orange, shining. Genitalia, in male deep black, shining; in female last 3 segments with black erect hairs. Western Australia. . . . 14. *A. pulchra*, sp. nov. ♂, ♀

16 (13). Mesonotum uniformly yellowish dusted. Genitalia in male reddish, hairs on last tergites chiefly yellow. Viewed from above, upper edges of upper forceps form 2 elliptical spaces, first (at base) a little longer, and very narrow, 2nd (in profile sloping downwards) lens-shaped; in female last 3 segments with dense, erect red hairs. Western Australian. . . . . .12. *A. goerlingi*, sp. nov. ♂, ♀

Mesonotum uniformly yellowish dusted, but on humeral calli and notopleural depression there is a white longitudinal stripe. Genitalia in male brown; touching line of upper forceps forms 2 elliptical spaces; basal very long, narrow; apical broadly heart-shaped; in female last 3 segments covered with black erect hairs. Victoria, South Australia, Western Australia. . . . . 11. *A. maxima*, sp. nov. ♂, ♀

17 (12). A small narrow sclerite behind mesopleurae at upper corner covered with hairs only. 18

Above-mentioned sclerite with hairs and 1 or 2 strong bristles. 20

18 (17). Ground colour of whole body uniformly yellow, on abdomen distinctly shining. No black bristles or hairs. Ambient vein and vein m_{3+4} absent. Costa not extending to tip. Bernier I. (Western Australia). . . . . .16. *A. omniflava*, sp. nov. ♀

Ground colour not uniformly yellow, but black, brown, or if yellowish with various markings on mesonotum and abdomen. 19

19 (18). Seventh segment only of abdomen with erect black hairs. Vein *r-m* far beyond middle of discal cell. Third antennal joint deep black. Abdomen with 2 greyish longitudinal stripes, which are not very well developed. Halteres dark. . . . . 18. *A. latipennis*, sp. nov. ♀

Sixth and 7th segments covered with black erect hairs. Vein *r-m* near middle of discal cell. Third antennal joint bright orange-yellow. Abdomen with traces of transverse bands slightly darker than ground colour. Halteres yellow. South Australia, Western Australia. . . . . .19. *A. deserticola*, sp. nov. ♀
and (see description) Northern Territory. . . .17. *A. afacialis*, sp. nov. ♀

20 (17).[*]Ambient vein present not only on whole hind margin of wing, but even on hind margin of alula. Vertex in male as broad as a posterior ocellus, in female nearly equal to ¼ of head width. Fourth tergite in male has very numerous and strong black hairs-bristles along whole lateral margin. Lateral white longitudinal stripe on mesonotum in both sexes nearly absent. Tergites without markings. Last 3 segments in female with dense, erect, black hairs. Western Australia. . . . . .20. *A. tonnoiri* Norr. ♂, ♀

Ambient vein on hind margin absent or runs only to apex of anal cell. 21

21 (20). Ambient vein clearly visible running from apex of wing to apex of anal cell. Eighth sternite in male (as in *A. tonnoiri*) extremely well developed, much longer than 8th tergite 22

Ambient vein absent 23

22 (21). Vertex twice as broad as posterior ocellus. Whitish lateral stripes on mesonotum absent. Space between the upper forceps very long, narrow, a little broader at apex. Northern Territory. Female unknown. . . .21. *A. campbelli*, sp. nov. ♂

(♂) Vertex a little broader than posterior ocellus. Sides of mesonotum with a very well-developed white stripe. Space between upper forceps broad, at apex pear-like. (♀) Vertex about ¼ of head width. Ground colour of mesonotum with very broad, sharply marked white longitudinal stripe. Ground colour of tergites brown, with a broad, reddish median stripe, occupying about 1/3 of

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[*] When identifying species of *A. tonnoiri* group the reader is recommended to consult the description of the mysterious 9. *A. immedia* Hardy.

abdomen width. Only the last abdominal segment with erect hairs. Western Australia............................23. *A. norrisiana*, sp. nov. ♂, ♀

23 (21). Vein m_{3+4} always present. Subdiscal cell rather long, rectangular at lower external corner...24

Vein m_{3+4} absent; subdiscal cell regularly rounded at apex. Small species: length of body 12-13 mm. Apical palpal joint very narrow, elongated, tapering in apical part, as broad as labella; labella small, as broad as proboscis, occupying 1/3 of proboscis length. North Western Australia, Queensland.............
25. *A. norrisi* Hardy ♂, ♀

24 (23). Vertex in male as broad as ocellar triangle. Eighth sternite much longer than 8th tergite. Vertex in female less than 1/3 of head width. Only last segment of abdomen in female covered with erect hairs. New South Wales, Queensland.................................22. *A. oblonga*, sp. nov. ♂, ♀

Vertex in male distinctly broader than ocellar triangle. Eighth sternite only a little longer than 8th tergite. Vertex in female broader than 1/3 of head width. Last 3 abdominal segments in female covered with erect hairs. Queensland (coastal area).....................24. *A. imminuta* Hardy ♂, ♀

25 (11). Mesonotum with 3 brown and 4 yellowish, very sharply marked longitudinal, nearly parallel-sided stripes. Abdomen above with 2 yellowish and 3 brown longitudinal, nearly parallel-sided stripes 26

Mesonotum without well-marked longitudinal striping or if the stripes are present then the abdomen is cross-banded or without markings, or if there are longitudinal spots they never form complete, nearly parallel-sided stripes........30

26 (25). Males...29

Females..27

27 (26). Last 3 segments above and below with dense, erect, black hairs, directed a little towards the base of abdomen. Vertex much broader than eye. Middle dark brown stripe on mesonotum very broad and not divided by a narrow central yellowish stripe; nearly as broad on anterior margin as at scutellum. Length of body 18.5 mm. Western Australia............28. *A. fullerae*, sp. nov. ♀

Only last (7th) segment with dense, erect, black hairs. Vertex at most as broad as eye. Middle dark brown stripe on mesonotum divided by narrow, but distinct yellowish stripe; on anterior margin it is distinctly broader than at scutellum...28

28 (27). Face on level of antennae distinctly broader than horizontal diameter of eye. Middle brown stripe on the 2nd and following tergites twice as broad as greyish submedian ones. On 2nd, 3rd, and 4th tergites there are brown spots at boundary with sternites. Length of body 17 mm. New South Wales...........
27. *A. nicholsoni*, sp. nov. ♀

Face on level of antennae narrower than horizontal diameter of eye. Middle brown stripe on abdomen only a little broader than the greyish sublateral ones. At boundary of tergites and sternites no brown spots. Length of body 17-19 mm. New South Wales, Queensland, Victoria..........26. *A. hardyi*, sp. nov. ♀

29 (26). Lateral margin of 2nd, 3rd, and 4th tergites with brown rounded spots..........
27. *A. nicholsoni*, sp. nov. ♂

Lateral margin of tergites uniformly greyish, no brown spots.................
26. *A. hardyi*, sp. nov. ♂

30 (25). Three basal sternites with 3 brown, longitudinal, narrow stripes (a character up to the present time known to occur only in this species). Length of body 18 mm. New South Wales....................29. *A. striativentris*, sp. nov. ♂, ♀

Sternites uniformly whitish 31

31 (30). On side of 2nd, 3rd, and 4th tergites at junction with sternites there is a broad, parallel-sided, brown, longitudinal stripe. On mesopleurae, sternopleurae, and above hind coxae there are large, irregular brown spots. Mesonotum very

dark brown, nearly black, with 2 narrow submedian whitish or yellowish interrupted stripes and similar lateral stripes. These stripes are very sharply marked. New South Wales, Queensland. (Female unknown.) .... 30. *A. lugubris,* sp. nov. ♂

Sides of 2nd, 3rd, and 4th tergites without brown stripes or only isolated rounded brown spots. Mesopleurae and sternopleurae without brown spots. Mesonotum not dark brown, with or without well-developed markings, or the markings are broad 32

32 (31). Apical joint of palpi tapered from the middle to the apex. Greyish markings on 2nd, 3rd, and 4th tergites forming 2 pairs of triangles: one on anterior, the other on posterior margins. "Australia." (Female unknown.) Very similar to *A. brevicornis* .... 40. *A. acutipalpis,* sp. nov. ♂

Apical joint of palpi always widened in its apical ½ and broadly rounded at apex; always broader at apex than at base 33

33 (32). Median veins (m_1, m_2, m_3) and sometimes the other veins reaching the hind margin of wing partly or wholly pale, much weaker than other veins 34

All veins equally developed, only the tips of median veins may be a little weaker . . 37

34. Subdiscal cell is connected with hind margin of wing by vein m_{3+4}. Third antennal joint pear-like, nearly equal to the 1st one. Palpi whitish-haired. Northern Territory .... 33. *A. tropica,* sp. nov. ♀, and ...... 34. *A. angustifrons,* sp. nov. ♂ (vertex occupying 1/7 of head width; it is possible that they are both sexes of same species).

Subdiscal cell isolated from hind margin of wing 35

35 (34). Ambient vein present on hind margin. Alula small. Victoria .... 35. *A. unicolor,* sp. nov. ♂

Ambient vein absent or nearly invisible. Alula large or small 36

36 (35). Alula large. Vein *r-m* distinctly beyond middle of discal cell. Abdomen predominantly whitish in colour. Lateral whitish triangles on 2nd tergite distinctly reaching the hind margin, very broad and high (distinctly longer than ½ a tergite). A very clear white spot in middle of scutellar sutura. South Australia . . 32. *A. contrasta,* sp. nov. ♂

Alula small, but distinctly longer than triangular cell at base of wing. Vein *r-m* in middle of discal cell. South Australia..... 31. *A. latifrons,* sp. nov. ♂, ♀

37 (33). Ground colour of body reddish, dull or shining. Length of body about 22 mm. . 38

Ground colour of body black, dark brown, brownish, or partly reddish. If the last, length of body distinctly less than 22 mm 39

38 (37). Ground colour is dull. Mesonotum without black median line. No black bristles anywhere on body. South Australia, Western Australia .... 36. *A. ferruginea,* sp. nov. ♂

Ground colour shining. Mesonotum with black median stripe. Bristles on antennae, occiput, etc. black. Queensland .... 37. *A. vulpes* Herm. ♀

39 (37). Large species, length of body at least 22 mm. Along anterior margin of 2nd and 3rd tergites at sides there are greyish transverse triangles (viewed from above). Markings of abdomen yellowish grey, not very contrasting with dark markings . . 40

Small species, up to 17 mm, if larger, whole anterior part of 2nd and 3rd tergites dark brown; without greyish or whitish spots or triangles, but these present on posterior part of tergites. Spots or triangles on abdomen mostly whitish or whitish grey, rather contrasting with dark markings 41

40 (39). Male. Frons in male with brown hairs; palpi with black bristles. Mesonotum markings very poorly developed, mesonotum nearly uniformly yellowish dusted on dark ground. White hairs on 1st 3 sternites, not very long.

Female. Vertex in female narrower than 1/3 of head width. Whitish hairs only on 2 basal sternites, remainder black-haired. Larger species. Western Australia .... 61. *A. fasciata,* sp. nov. ♂, ♀

Frons in male with white and some yellowish hairs. Mesonotum markings rather well developed. White hairs on 1st 4 sternites very dense and extremely long, longer than sternites themselves. Vertex in female broader than 1/3 of head width. Whitish hairs on 4 basal sternites. Smaller species, New South Wales. .
58. *A. orientalis*, sp. nov. ♂, ♀

41 (39). Abdomen with longitudinal greyish striping (but not so regular as in *A. hardyi* group). Stripes composed of rows of spots in form of very narrow "brackets," or of greyish triangular spots at hind margin of tergites, very narrow and high, nearly reaching anterior margin, or greyish spots of very irregular form have a longitudinal direction. Mostly medium-sized species..................42

Abdomen with greyish cross bands or pairs of triangles, disposed in transverse rows, never with greyish spots arranged distinctly in longitudinal direction........45

42 (41). Abdomen with very narrow "bracket-like," longitudinal greyish markings......43

Abdomen with triangular or irregular longitudinal markings................44

43 (42). Male (female unknown). Distance between the "brackets" on 2nd tergite a little greater than width of each "bracket." Western Australia..................
48. *A. englishae*, sp. nov. ♂

Female (male unknown). Distance between "brackets" on 2nd tergite approximately ⅓ of segment width..............46. *A. longitudinalis*, sp. nov. ♀

44 (42). All available material from this group is so badly preserved that the author cannot attempt to describe the species.

45 (41). Large species, as a rule at least 18 mm in length, with broad and comparatively short abdomen, the apical ½ of which is tapered very sharply. Second tergite distinctly more than twice as wide as long. *A. asilica* group*............61

Species less than 18 mm long. Abdomen narrower, regularly tapering towards the tip. Second tergite only a little more than twice as wide as long............
A. brevicornis Wied. group..46

46 (45). Males...47

Females...54

47 (46). Vertex comparatively broad, at least ¼ of head width......................48

Vertex narrow, always distinctly less than ¼ of head width..................49

48 (47). On anterior border of 2nd and 3rd tergites there are white triangles. Length of body 17 mm. Western Australia..............42. *A. moderata*, sp. nov. ♂

Anterior border of 2nd and 3rd tergites without white triangles. Length of body 14.5 mm. New South Wales..................43. *A. aliena*, sp. nov. ♂

49 (47). No brown markings on frons. Tuft of hairs flanking supra-alar row of bristles white. Proboscis short, reaching only to apex of antennae. Only a few black hairs at side of 1st tergite, nearby some black bristles. Last (9th) sternite small, distinctly visible in heart-shaped opening between the lower forceps. Queensland....................................44. *A. regina*, sp. nov. ♂

Brown markings on frons always present. Tuft of hairs flanking supra-alar row brown. Proboscis often protruding far beyond apex of antennae. Dense tuft of brown hairs on side of 1st tergite. Opening between lower forceps triangular, occupied wholly by 9th sternite...................................50

50 (49). Bottom of mouth cavity with pale hairs. On anterior ½ of 2nd tergite there are numerous, very long, white hairs, much longer than dark hairs on posterior ½. Second ½ of abdomen tapering very abruptly.......................51

Bottom of mouth cavity without hairs. Hairs on anterior ½ of 2nd tergite dark, or if white not long, only slightly longer than those on posterior ½. Second ½ or abdomen tapering regularly 52

51 (50). Vertex very narrow, occupying about 1/7 of head width. Anterior ocellus occupying 1/3 of frons width at its level. Forma typica. Western Australia............
49. *A. asiloides*, sp. nov. ♂

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* The species of these groups are so similar that it is recommended that both alternatives be followed, especially if species are intermediate in size (16-18 mm).

Vertex a little broader, occupying about 1/6 of head width. Anterior ocellus occupying a little less than 1/3 of frons width at its level. Forma atypica (its exact taxonomic value can be stated only after examination of better-preserved material). Western Australia.

52 (50). Third antennal joint elongated, about twice as long as both basal joints combined; elliptical, never pear-like....................39. *A. similis*, sp. nov. ♂

Third antennal joint about as long as the first, distinctly pear-shaped..........53

53 (52). Mesonotum predominantly brown, with well-marked longitudinal stripes. Very broad sublateral brown stripe of mesonotum nearly complete, i.e. only slightly separated into 3 spots or wholly complete. Labella big, about as long as antennae. Length of body 14-17.5 mm..................38. *A. brevicornis* Wied. ♂

Mesonotum mostly greyish, with not very sharply marked longitudinal stripes. Broad sublateral brown stripe of mesonotum distinctly separated into 3 spots. Labella small, at most as long as both basal antennal joints combined. Length of body 13-14 mm..........................47. *A. albanyana*, sp. nov. ♂

54 (46).*On anterior margins of 1st to 4th tergites there are white markings, mostly of triangular shape..55

No white markings on anterior margin of tergites........................56

55 (54). Vertex broader than 1/3 of head width. Western Australia.................. 42. *A. moderata*, sp. nov. ♀

Vertex equal to 1/3 of head width. Victoria........41. *A. victoriae*, sp. nov. ♀

56 (54). Bottom of mouth cavity with short hairs. Western Australia................ 49. *A. asiloides*, sp. nov. ♀

Bottom of mouth cavity quite bare.................................57

57 (56). Third antennal joint elongated, elliptical, never pear-shaped, longer than 2 basal joints combined..........................39. *A. similis*, sp. nov. ♀

Third antennal joint pear-shaped or nearly so, shorter than 2 basal joints combined..58

58 (57). Labella small, at most as long as 2 basal antennal joints combined, a little broader than proboscis. Length of body 14 mm. Western Australia................ 47. *A. albanyana*, sp. nov. ♀

Labella large, longer than 2 basal antennal joints combined, and much broader than proboscis. Larger species.................................59

59 (58). Sublateral brown longitudinal stripes on mesonotum very well developed, large, sharply contrasted with greyish stripes and nearly complete, i.e. not separated by greyish cross bands into 3 spots. Whitish triangles on 2nd tergite always small, narrow...............................38. *A. brevicornis* Wied. ♀

Mesonotum striped, but the brown and greyish stripes contrasting only slightly; brownish sublateral stripe always separated into 3 spots..................60

60 (59). Length of body at most 18 mm. Queensland........44. *A. reginae*, sp. nov. ♀

Length of body 19 mm. South Australia..........45. *A. picoides*, sp. nov. ♀

61 (45). First and 2nd tergites predominantly white; median dark spot of 1st tergite always much smaller than submedian white spots. Queensland.................. 60. *A. commoni*, sp. nov. ♂, ♀

First and 2nd tergites predominantly dark; median dark spot on 1st tergite always larger than white submedian spots...............................62

62 (61). Second tergite white, with very broad "T"-shaped black marking, head of "T" straight, no broader at sides than in the middle. Sixth and 7th segments of female covered with black erect hairs, directed towards base of abdomen. Length of body 20-24 mm, of wing 12-16 mm. Western Australia.......... 59. *A. pica* Norr. ♂, ♀

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* The identification of females requires well-preserved specimens, and material for comparison, because the species of this group are very closely related.

Second tergite mostly black; black pattern not "T"-shaped, but resembles a broad arrow. Only 7th segment of abdomen in female with erect black hairs......63

63 (62). Mouth cavity with rather dense and long yellowish hairs on bottom (not at sides)..64

Mouth cavity quite bare at bottom......................................65

64 (63). Mesonotum sharply striped brown and greyish. White triangles on tergites so high that they almost reach the anterior border; abdomen very sharply marked with black and greyish markings. Mesopleurae whitish. Six bristles on scutellum. South Australia....................53. *A. swani*, sp. nov. ♂, ♀

Mesonotum striped, but not sharply. White triangles on tergites well developed, but never reaching anterior margin. Mesopleurae whitish, but with a distinct brown longitudinal stripe under row of notopleural bristles. Four bristles on scutellum. Western Australia. (Also *A. asiloides*, sp. nov. and its "var.")....
62. *A. pilosoris*, sp. nov. ♂, ♀

65 (63). Antennae long, at least as horizontal diameter of head. First antennal joint shortened, only a little longer than its breadth at apex; 2nd joint ½ as long as 1st, much narrower; 3rd twice as long as 2 basal joints combined, fusiform, at broadest point as broad as 1st joint at apex. Cerebrale (middle part of occiput) on the level of postocular bristles quite bare. Vertex much broader than 1/3 of head width. South Australia, Northern Territory (male unknown)........
55. *A. antennata*, sp. nov. ♀

Antennae comparatively short, shorter than horizontal diameter of head. First joint distinctly longer than broad. Third joint as long as 2 basal joints combined or slightly longer..66

66 (65). Third antennal joint as long as 2 basal joints combined, narrow; at broadest point of same width as broadest point of 1st joint; elliptical, cigar-like. Sternopleurae and metapleurae sparsely haired. Bristles on coxae white (male unknown). Northern Territory.....................56. *A. septentrionalis*, sp. nov. ♀

Third antennal joint may be slightly shorter than 2 basal joints combined, pear-shaped, never elliptical. Sternopleurae, mesopleurae, and other parts very densely and long-haired, forming long tufts.........................67

67 (66). Two basal joints and basal part of 3rd joint of antennae rather bright yellow. Very sharply marked on mesonotum and abdomen, usually greyish stripes on mesonotum replaced by distinct yellow. Scutellum yellow dusted. Probably eastern Australia.................................57. *A. ornata*, sp. nov. ♂

Antennae black or blackish, never with any joints bright yellow, at most dirty yellow..68

68 (67). Vertex in male broad, 1/4-1/3 of head width. Apical joint of palpi only slightly broader than basal (female unknown). South Australia..................
54. *A. basivillosa*, sp. nov. ♂

Vertex in male about 1/5 of head width. Apical joint of palpi much broader than basal..69

69 (68). Dull species, brown and grey stripes on mesonotum not contrasting, nor are grey and black markings of abdomen. Vertex in male occupying approx. 1/7 of head width. Palpi (especially basal joint) with black bristles. Face very often with 2 oblique tufts of black hairs. Rather common species in mountain areas..
51. *A. asilica* Westw. ♂, ♀

Contrasts in colour more marked. Vertex in male occupying about 1/6 of head width. Palpi without black bristles, whitish-haired. Face as a rule white-haired. Rather common species in plain areas....52. *A. moerens* Westw. ♂, ♀

I. *Apiocera maritima* group

This group comprises only 3 species: *A. maritima* Hardy, *A. excepta*, sp. nov., and *A. pallida* Norris. All 3 inhabit sand dunes on the sea-shore, and show adaptation to the colour of the background in their white colour and reduced, very pale venation. They all have a tendency to become greasy in collections. The group is heterogenous, but there are characters common to all species.

The frons in the male is comparatively very broad (about 1/3 or much more of head width), in the female extremely broad (about ½ and more of head width).

In *A. maritima* and *A. excepta* the frons is extraordinarily broad, the vertex is broader than the distance between the eyes in the area of the mouth cavity (in female of *A. pallida* only slightly), whilst as a rule in other groups the above-mentioned dimension is distinctly broader than the vertex.

The venation of *A. excepta*, especially in the lack of r_4, may cause confusion in identification, because all keys of families agree that r_4 is present in the Apioceridae. The position of m_1, running to the tip of the wing itself, is also aberrant, because as a rule in Apioceridae it touches the anterior margin of the wing, but the author emphasizes that the marked similarity in other respects does not warrant the creation of a new genus.

It is very possible that this group includes more species, but the author only had access to material from the Perth area and from the sand dunes of eastern Australia. No material was available from Victoria, South Australia, north Western Australia, and the Northern Territory.

Where these species are present, they are abundant; even on much-frequented city beaches. Unfortunately among the thousands of beach visitors there are few collectors.

The life history of *A. maritima* was described in detail by English (1947). *A. pallida* is intermediate between this group and other apiocerids.

It is necessary to add that Cazier (1941) mistakenly inferred Hardy's figure of the wing of *Scenopinus civiculus* Hardy to be that of *Apiocera maritima* Hardy, and that his redrawing of this figure even resulted in an inaccurate representation.

1. APIOCERA MARITIMA Hardy ♂, ♀

Hardy, 1933, Proc. Linn. Soc. N.S.W. **58**: 416, fig. 1; 1940, **65**: 488.

Hardy's description is quoted below:

"This fly has the thick pulverulent covering, whitish in colour, that makes the ground colour hardly discernible and there is no pattern. The basal segments of the antennae, the palpi and the legs are tinted with brown, but the third segment of the antennae, the eyes and proboscis are black. The hairs throughout the head, body and legs are light grey. Normally on the female the seventh segment of the abdomen is retracted within the sixth, and it is brown, like the eighth, which protrudes beyond the sixth. The prosternum is small and is surrounded by a membraneous area that is covered with hairs and hence has the appearance of being a sclerite and not membraneous in texture. The venation is more or less, and sometimes considerably, reduced, but it varies towards the normal type; any of the veins, the fourth and fifth radian and the

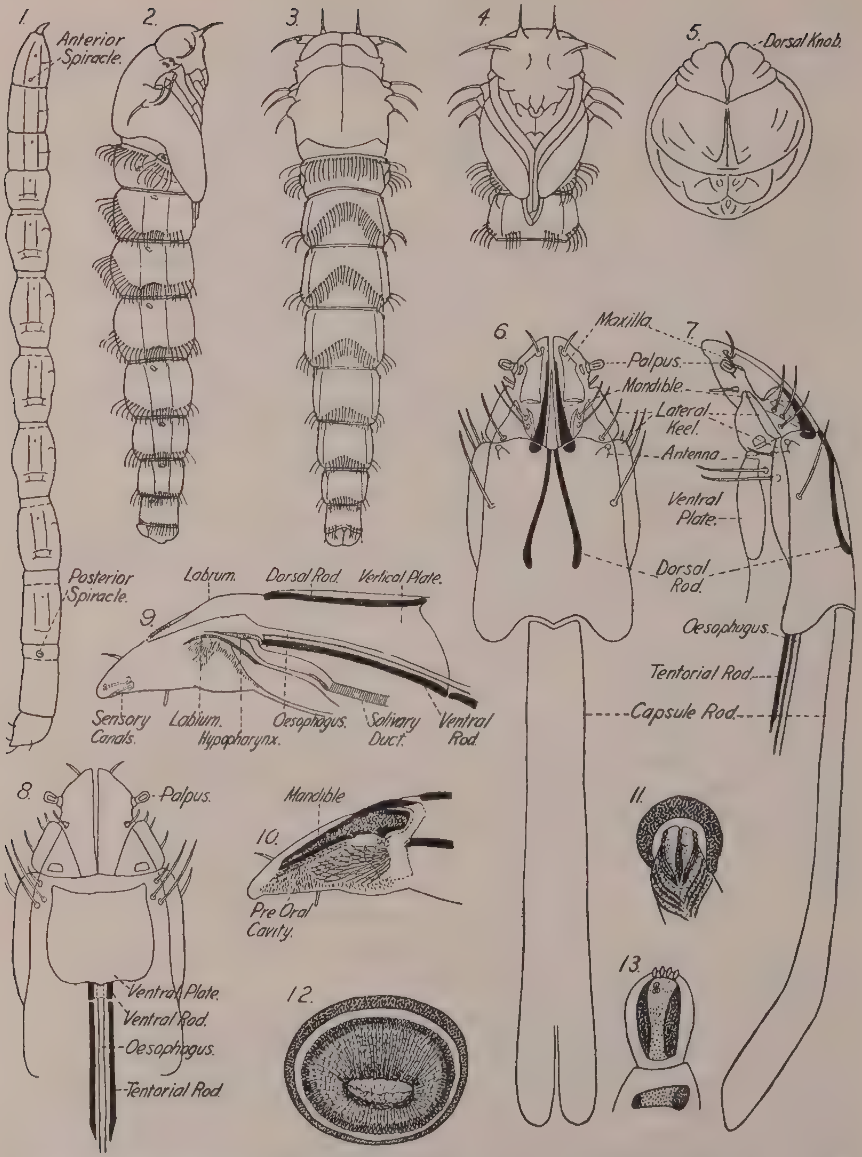

Fig. 4.—*Apiocera maritima*. 1. Larva, lateral view, × 3. 2. Pupa, lateral view, × 4. 3. Pupa, dorsal view, × 4. 4. Anterior end of pupa, ventral view, × 4. 5. Posterior end of male pupa, × 16. 6. Head of larva, dorsal view, × 30. 7. Head of larva, lateral view, × 30. 8. Head of larva, ventral view, × 30. 9. Vertical section of larval head, showing labrum and labium, × 50. 10. Vertical section of larval head, showing mandible and pre-oral cavity, × 50. 11. Anterior spiracle of larva, surface view, × 55. 12. Posterior spiracle of larva, surface view, × 55. 13. Palpus, × 100. (After English 1947.)

median, may be short or even missing. The diagram given here to show the character of the head appendages will enable the fly to be reliably determined even if other characters be ignored.

Terminalia.—There are two well-defined lamellae on the ovipositor and these are placed in the normal position, being contiguous along the median line. There is a structure that seems to represent a hinged median plate, the two together being situated at the base of the anal papilla, forming a V-shaped depression there, but this is not apparent until the anal papilla is exserted and the two plates, forming the arms of the "V," are drawn apart. The gonopore is situated within a genital groove that is bordered by a chitinous ridge that surrounds it on three sides. This ridge represents two lateral arms of chitin joined by a cross-piece at the base to form a single sclerite. The ninth tergite has at least eight spines placed along the apical edge each side of a strong upstanding dorsal ridge. The eighth sternite appears to be simple, but part of it is turned inwards so that the cleft at its apex becomes hidden within the genital cavity.

On the male, both upper and lower forceps are present, the claspers being fused to the latter. The lamellae are formed by three long plates, the upper ones narrow, the lower one being very broad, translucent and dark at the tip. The other characters were not made out with assurance, but the aedeagus seems to be short.

Hab.—Queensland: Southport, November and December, 1931, 5 ♂, 3 ♀, all taken on the coastal dune along the foreshore of Ocean Beach, Burleigh, 9th January, 1932; 1 ♀ in the collection of Mr. B. Blumberg.

Note.—This is one of the sand-coloured flies that frequent sand-dunes and all of which have same light grey pulverulent covering, often tinged with brown. With it occured a similarly coloured robberfly of the tribe Clinopogonini and a smaller one of the same tribe not so coloured, also *Anabarrhynchus maritima* Hardy (Therevidae) and *Sarcophaga litoralis* J. and T., besides a few Acalyptrate flies. Later, when *Apiocera maritima* became scarce in December, males of another became plentiful, a rather black species, of which I have not seen the female."

The sides of the frons are convergent from the vertex towards the antennae. Ratio eye: vertex in male = 1:2; in female 1:2.5. All bristles and hairs on body and legs are whitish or yellowish. The vein r_5 is 1.5 times as long as r_4. Subdiscal cell (M_3) is long, only a little shorter than discal cell. Veins r_4, r_5, m_1, m_2, and the veins at least on distal ½ of discal cell and of the cell M_3 very weak, pale.

Length of body 13-16 mm. Common on coastal sand dunes.

There are 2 forms: one smaller, with pure white dusting and without yellow markings (particularly on middle of abdomen); the other much larger, with more yellowish dusting and distinct yellow spots on the abdomen, but so far the author has not found satisfactory morphological differences between these 2 forms.

The author has seen specimens from the following localities.

NEW SOUTH WALES: 4 ♂♂, 6.ii.1927, 1 ♀, 15.i.1927, Curl Curl Beach (B. Bertram); 1 ♀, 26.i.1925, Harbord (B. Bertram); 1 ♀, 24.i.1921, Bondi, Sydney (W. A. Rainbow); 1 ♂, 1 ♀, Freshwater, Sydney; 1 ♂, 1 ♀, 1939, Narooma (K. English); 2 ♂♂, 3 ♀♀, 29.xi.1937, Gerroa (A. L. Tonnoir); 1 ♂, Jan. 1940, Narooma (A. L. Tonnoir); 2 ♂♂, 1.i.1932, Cronulla (F. J. Gay); 9 ♂♂, 3 ♀♀, 2.i.1950, Pittwater (K. R. Norris). QUEENSLAND: ♂♂, ♀♀, 10-12.i.1948, Tugun (K. R. Norris).

2. APIOCERA EXCEPTA, sp. nov. ♂, ♀

Belongs to the group *A. maritima*, but differs from all species of *Apiocera* by absence of vein r_4—a character which could lead even to wrong identification of family.

Ground colour of body chocolate-brown to nearly black, rather shining, making it distinct from other species of *A. maritima* group which have a very dense white or yellowish dust.

Proboscis dark, short, reaching to or a little beyond the apex of 2nd antennal joint. Palpi long-haired, not reaching the apex of 1st antennal joint. Apical palpal joint in male only a little broader than the basal; in female distinctly broader. Antennae approximately as long as head. Third antennal joint a little shorter than 2 basal joints together, it is soft and as a rule a little deformed, very egg-shaped and elongated; short style at apex not much narrower than this joint itself, which occurs in many species; 1st joint is a little thicker; bristle-like hairs on basal joints long and dense. Face extremely broad, parallel-sided, frons broader towards the vertex, occupying at that point much more than ½ of head width in both sexes. Frons, face, and occiput with dense yellowish dusting and dense hairs of same colour. Vertex is approximately 4 times broader than ocellar triangle. Hairs and bristles on whole body yellow with no black ones.

Mesonotum a little shining, blackish, without stripes or spots. Bristles on humeral calli very weak, all others strong; 4 bristles on scutellum. Wings hyaline, with nearly unnoticeable yellowish suffusion. All veins yellow, apical parts of veins at hind border of wing very weak, nearly obsolete at apex. Alula elongated, distinctly larger than triangular cell at base of wing. Axillary cell very large, broadly rounded, broader than anal cell and lower basal cell combined. Subdiscal cell isolated from hind margin, only a little shorter than the discal one, but nearly as broad. Costa strong, but not reaching apex of wing. Ambient vein absent. Halteres and legs yellow.

Abdomen regularly conical, a little broader at base than thorax, rather shining. No markings, but in male the last 2 tergites with poorly developed whitish markings, in female the last 2 or 3 tergites nearly whitish. Hairs on abdomen extremely short, except laterally at base. Genitalia of male short, distinctly shorter than the 6th and 7th tergites together; upper and lower forceps nearly equal, 9th sternite very short, viewed from below a very large space is visible between the lower forceps. In female only the last segment with erect dense hairs.

Length of body 17 mm, of wing 15 mm.

NEW SOUTH WALES: 1 ♂, 5 ♀♀ (Macleay Museum); 23 ♂♂, 32 ♀♀, 22.xii.1948, Manly Beach (K. R. Norris); 1 ♂, 1 ♀, 2.i.1950, Pittwater (K. R. Norris); 1 ♀, 2.i.1950, Bawley Point (A. J. Nicholson). QUEENSLAND: 1 ♀, 10.i.1948, Tugun (K. R. Norris).

Types in Macleay Museum, Sydney.

3. APIOCERA PALLIDA Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. 22: 59.

Norris's description is quoted below:

"A hairy species which is a parallel to *Apiocera maritima,* Hardy, being predominantly white in colour and occurring on white sand dunes and adjacent sandy regions.

Male: Head: Ground colour, black, but completely obscured by dense white pulverulence. Eyes separated at vertex by about two-sevenths of head-width. Inner margins of eyes fairly straight, diverging out at base of head. Ocellar region with light brown hairs projecting up from the white tomentum. Lateral ocelli well separated from eye. Height of ocellar triangle about one and a half times the base. Below ocellar region the hairs are white, extending round oral rim to join the hairs on the back of the head.

Antennae: Basal segment brown, covered with white tomentum, armed distally with long pale bristles, proximally with soft white hairs. Second segment black, globular, with white tomentum and a circlet of pale spines. Third segment yellow at base, black distally, with a patchy white pollen. Style black. Basal and distal segments equal in length.

Palpi equal in length to antennae, basal segment cylindrical, ground colour yellowish-grey; with loose white tomentum and with a sparse coat of long white hairs. Distal segment more or less truncate apically; with white tomentum and a few white hairs.

Proboscis black, about one and two-thirds as long as head capsule and in a similar proportion to length of antennae.

Height of head two-thirds of width, and width two and one-third times length.

A groove marks off face and genae from rim-like edge of oral cavity.

Back of head with white tomentum and a dense ruff of radially-arranged hairs extending down to bases of palpi. Behind each eye apex is a tuft of yellowish bristles. No black bristles at all upon head.

Thorax vittate above. Ground colour blackish. Pronotum white, with white hairs and only white spines above. A median white stripe is present on mesonotum, which fades out before the scutellum. This stripe is flanked by a pair of broader black ones, and these in turn by a white pair which diverge and broaden anteriorly. Humeral calli white. A white patch just above wing-base; another but larger between humeral callus and suture, this latter mark being in the form of an inwardly pointing wedge. Scutellum black. Post-scutellum with white pollen. Ventral and pleural regions with very dark ground colour obscured by dense coating of white pulverulence and white hairs. A tuft of black bristles on humeral callus, lateral thoracics mostly black; a few, however, are pale and yellow. Post-alar callus with a tuft of long bristles, about one-half of which are pale. Scutellar bristles black. Dorsum of thorax with an even coating of short, erect, brown hairs. In front of and on scutellum these become white and longer. There is a few white hairs at anterior of mesonotum as well.

Legs: Coxae and femora yellowish, with white pulverulence and white hair; bristles pale. Tibiae and tarsi yellow, the former with white pollen; bristles yellow proximally, black on terminal leg segments.

Wings hyaline, costa pale, median vein black, remainder brown. Median thyridium particularly obvious. Squamae with dense white fringe. M_1 and M_2 very weak and pale. Free part of M_{3+4} short or absent. Halters yellowish-brown.

Abdomen short; tergites black, brown laterally. Sternites brown. Tergites edged with white posteriorly. Fourth and fifth tergites with paired white patches above. Those parts of the tergites visible from the sides are mostly white, but tergites two, three and four have brown lateral patches. The four basal tergites have dense white hairs above. Segment five is partly so; but hair of remainder of dorsum is black. Venter entirely with white pollen and white hairs which are longer at the base.

Terminalia brown, with dense white tomentum and white hairs. Similar to those of *A. pica* sp. nov. in shape.

Female: Front wider than in male, occupying two-fifths of the head-width. Abdomen not nearly so hairy dorsally and differing in dorsal pattern. There is a slender, brown, median stripe, and broad paired lateral brown spots on tergites 2-5.

Measurements: Male, body 16 mm., wing 10 mm. Female, body 16 mm., wing 11 mm.

Hab.: Garden Island, W.A., 1 female, 11th March, 1933, 1 male, 23rd February, 1935, K. R. Norris. Carnac Island, 18 males, 4 females, 2nd February, 1936, K. R. Norris.

Mr. L. Glauert has shown me a specimen collected at Cottesloe on the mainland.

Notes: The first specimen taken was the female from Garden Island. It was perching on a bush on a cliff above the sea. The male from Garden Island was taken on a sand-dune, where other specimens were also seen in a growth of *Calocephalus brownei*. On Carnac Island the species was extremely common, but males were preponderant. Three of the females were evidently recently emerged and were very sluggish, but the males were agile and pugnacious, continually indulging in aeriel duels with one another. They occurred on the loose white dunes and beach sand, and also on the more compact earth away from the shore. One female was removed from the possession of a small female Asilid of genus *Cerdistus*. The males may be as small as 13 mm. in length."

The author has seen typical specimens of this species and one male from Geraldton, W.A. (J. Clark, 24.ii.1914). It is noteworthy that the bristles on mesonotum are mostly yellowish. Ratio vertex: eye in male is 2:2.5, in female 4:3. Length of body 16 mm, of wing 10 mm. Western Australian species.

II. *Apiocera minor* group

This group contains 5 species: *A. minor* Norr., *A. newmani* Norr., *A. mackerrasi*, sp. nov., *A. australis*, sp. nov., *A. vespera*, sp. nov. It is not quite homogenous, but has sufficient common characters to be regarded as one rather natural unit.

The most important character is a poorly developed alula: in *A. minor* and *A. newmani* it is much smaller than triangular cell at base of wing, almost ribbon-like, in other species it is nearly equal to triangular cell and triangular in shape. All 5 species (excluding *A. minor*) have neither ambient vein nor vein m_{3+4}. As a rule in males the vertex is comparatively very broad, about 1/3 or more of head width.

A comparatively long proboscis and long bristles on the mesonotum are also typical characters of this group.

Although the mesopleurae are not quite bare anteriorly, the hairs in general are very poorly developed.

4. APIOCERA MINOR Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. **22**: 61.

Norris's description is quoted below:

"*Male*: Head-height seven-tenths of width. Eyes widely separated, being three-eighths of the head-width apart at vertex. Inner margins of eyes are parallel. Separation of eyes at vertex is three times the width of ocellar tubercle. Paired ocelli separated from eye margin by a distance which is greater than the distance between them. Ocellar triangle equilateral. Head-capsule black, completely covered with white tomentum. Front and ocelli sparsely covered with long brown hairs, absent from a median region above the antennae, where the tomentum is brown.

Antennae black, long and slender. Basal segment dusted white; when viewed from above with a straight inner margin and a strongly covex outer margin; with a few long black spines, and on the outer face white hairs. Second segment globular, dusted white; a few long black spines in a whorl round its middle. Terminal segment black, cigar-shaped, dusted silvery white; apt to crumple in dried specimens. The third segment is about one-third as long again as is the basal, whilst the black bristles with which the antennae are armed are about equal in length to that of the basal segment. Style prominent.

Face of considerable breadth. Genae with a fringe of white hairs.

Palpi slightly more than three-quarters of the antennal length, basal segment cylindrical, light brown with numerous long white hairs below; equal in length to two-thirds that of the distal segment. Terminal segment cylindrical at base, flattened distally, rounded apically, light brown in colour but darker distally; thin black bristles near upper margin and soft white hairs below.

Proboscis slender, black, twice as long as head; folded labella smoothly angulated apically, distinctly broader than proboscis in profile.

Epistome almost squarely transverse. Face and genae with soft white hairs. Posterior aspect of head with long white hairs and a fairly large tuft of black spines behind the apex of each eye intermingled with white hairs. The hairs near the insertion of the palpi and on the basal segment of these appendages are particularly long.

Thorax: Ground colour black. Pronotum with black spines and white hairs above. Mesonotum with a greyish dust and a pattern of greyish white marks, corresponding roughly in distribution to those of *A. pica* sp. nov. Humeral callus with a tuft of short black bristles. Lateral thoracics and scutellars are extremely long. Pleurae covered with white tomentum and white hairs. A tuft of black bristles above anterior coxae. Mesonotum with an even coating of short brown hairs; those of scutellum white.

Legs brown, long; coxae with white hairs and tomentum and white bristles.

Wings hyaline, normal. Halters brown.

Abdomen: Ground colour, brown. Basal tergite with a pair of white stripes corresponding with lateral edges of scutellum. Second tergite with a pair of similar white stripes posteriorly, half the length of the tergite. The pattern on the third and fourth tergites can perhaps best be described as a black broad arrow on each, pointing forwards; remainder white. Remainder of tergites with white tomentum and a median black stripe. Sternites with white tomentum and anteriorly, white hairs. Basal tergite with a few white hairs, and on either side posteriorly a tuft of black bristles.

Terminalia covered with black bristles, clasper bearing a few black spines below.

Female: Larger than male, front not broader, most readily distinguished from male by the terminalia.

Measurements: Male, body 12.5 mm., wing 7.5 mm.
Female, body 12.5 mm., wing 8 mm.

Width of thorax in both sexes 3 mm.

Hab.: Carlisle, W.A., 2 females, 1 male, D. Swan. Mullewa, W.A., 1 female, 1 male, L. J. Newman. Gnangara, W.A., 1 female, November, 1930, O'Connor. Yelbeni, W.A., 1 female, September, O'Connor. Kalgoorlie, W.A., 1 female, September, L. J. Newman."

This species is easily distinguishable by these very peculiar characters:

(1) Alula extremely narrow, with nearly straight hind margin, as broad as humeral cell, much smaller than the triangular cell at base of wing,

(2) Bristles very numerous, strong, and long (supra-alar bristles nearly as long as vertical diameter of head),

(3) Length of body only 12-13 mm; abdomen narrower than thorax, regularly tapering towards apex,

(4) Mesonotum without very well-pronounced pattern,

(5) Second to 6th tergites with a pair of small greyish vertical triangles at hind border,

(6) Last sternite and the lower genital plate (9th tergite) with very long black hairs in male; in female only last (7th) segment with dense, erect, black hairs,

(7) Proboscis long, 2.5-3 times longer than head,

(8) Labella distinctly broader than proboscis in profile.

Among black bristles at the sides of mesonotum (notopleural) there are no black hairs, which, for example, in *A. brevicornis* form a very narrow but distinct dark stripe.

The author has seen specimens from the following localities:

WESTERN AUSTRALIA: 2 ♂♂, 21.x.1941, Piawaning (K. R. Norris); 2 ♂♂, Swan River (J. Clark); 1 ♀, 10.xi.1940, Capel (P. N. Forte); 1 ♀, 17.xi.1938, Lime Lake (K. R. Norris); 2 ♂♂, Bullsbrook ("37-3623, 3625"); 2 ♀♀, 23.xi.1941, Kojonup (P. N. Forte).

5. APIOCERA MACKERRASI, sp. nov. ♂

Very similar to *A. newmani*. A small, narrow, elongated species with comparatively poorly developed pattern.

Ground colour of body dark, nearly black, somewhat shining on abdomen. Proboscis at least twice as long as head. Labella broad, black, as long as 2 basal antennal joints together, occupying about 1/3 of the whole length of proboscis. Palpi brownish, comparatively short, reaching only to the apex of 1st antennal joint; apical joint of palpi only a little broader than basal; both slightly curved, with pure white, very thin hairs, but at apex there are some blackish ones. Antennae blackish, not so long as in *A. newmani*, a little longer than the head. Third antennal joint pear-like, of the typical *Apiocera* form, shorter than the 1st; bristles black, long, rather numerous.

Face white dusted, with long and numerous, very thin, pure white hairs; frons dusted with yellow, at sides more whitish, hairs long, numerous, brownish, a little curled. Viewed from front the sides of front and face are nearly parallel, slightly diverging towards the vertex and towards the lower points of eyes. Occiput dusted with pure white along the margin of eyes and with similar dense hairs; most of central part dusted brownish, with numerous blackish bristles. Vertex is 3 times broader than ocellar triangle, occupying distinctly more than 1/3 of head width. Ocellar triangle short, nearly equilateral.

Mesonotum brown, with 2 broad lateral greyish stripes (including humeral calli), but they are interrupted behind the humeral calli; there are also 2 narrow submedian greyish stripes, which extend from the anterior to the posterior margin, converging slightly; middle brown stripe which separates them is very broad (at least double the width of greyish stripes). Humeral calli with 2 or 3 fairly weak bristles; 4 strong notopleural bristles on greyish ground and with very few intermixed hairs. Three strong bristles on the postalar calli; 1 prealar, 1 supra-alar bristle; dorso-central bristles completely lacking; 4 bristles on scutellum, which is brown with greyish hind margin. Under side of thorax with long and dense pure white hairs. Wings quite hyaline. Alula rudimentary. Ambient vein absent. Subdiscal cell isolated, small, lens-shaped, not touching the lower basal cell. Vein *r-m* on the middle of discal cell; vein m_2 weak, at least twice as short as the well-developed m_1. Knob of halteres brown. Legs brownish yellow.

Abdomen very narrow, elongated, regularly pointed towards the tip. Dorsal side dusted brownish, with small greyish transverse markings along the hind margin of 1st to 4th tergites. Hairs very short and scarce, so that abdomen appears bare. Ventral side dusted white, with white hairs on first 4 sternites, remainder sparsely black-haired.

Genitalia short, equal to combined length of 6th and 7th segments. Ninth tergite very small, triangular, situated close to the lower forceps.

Length of body 12 mm, of wing 6.5 mm.

1 ♂, Oct. 1926, Eidsvold, Queensland (I. M. Mackerras). Type in the Division of Entomology Museum, C.S.I.R.O., Canberra. This species is named in honour of Dr. I. M. Mackerras.

6. APIOCERA AUSTRALIS, sp. nov. ♂, ♀

Small species with brown ground colour, undeveloped alula, without ambient vein, and with very short subdiscal cell.

Proboscis very long, 3 times longer than head, labella only a little broader than the remainder of proboscis; proboscis protruding very far beyond the antennae. Palpi very long, extending to centre of 3rd antennal joint, very narrow, apical joint only slightly curved, 1.5 times broader at apex than at base. Antennae as long as head. Bristles on head and its appendages brownish, hairs yellow. Vertex occupying nearly 1/3 of head width. Third antennal joint nearly pear-like, shorter than 2 basal joints combined.

Thorax brown, probably without well-marked pattern (neither of the male specimens available is very well preserved). Hairs on sides of thorax yellowish, rather numerous and dense. Legs and bristles reddish yellow. Halteres yellow. Wings hyaline. Alula as broad as humeral cell. Veins m_1, m_2, and m_4 usually dark. Vein m_2 1/3 the length of vein m_1 and diverging from it. Subdiscal cell very small, not touching the lower basal one. Vein m_2 very weak and short.

Abdomen narrow, elongated, conical, with very short genitalia; they are as long as penultimate segment. Hairs on abdomen very scarce and short; the abdomen is uniformly brownish, with no pattern.

Length of body 13.5 mm, of wing 7 mm.

Female.—Very similar to the male. Labella is as in male ¼ the length of the whole proboscis. Under side of palpi covered with very long white hairs, upper side with dark thin bristles. Only last segment with erect, dark, dense hairs. The female is a little larger than the male.

SOUTH AUSTRALIA: 2 ♂♂, 2 ♀♀ (Macleay Museum, Sydney); 1 ♀, Karoonda to Peebinga (G. E. H. Wright) (S.A. Museum); 1 ♀, Purnong; 1 ♂, 1 ♀, 11.x.1950, Waikerie (D. C. Swan). VICTORIA: 1 ♀, Mallee District (Melbourne Museum); 1 ♀, Kewell; 1 ♀, 15.xii.1945, Halls Gap (A. Burns); 1 ♀, 9.xi.1915, Lake Hattah, Mallee. WESTERN AUSTRALIA: 1 ♀, Geraldton (J. Clark); 1 ♀, Salmon Gums ("37-3463") (W.A. Museum).

Type in Macleay Museum, Sydney.

7. APIOCERA NEWMANI Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. 22: 62.

The author has seen the types. Only one female (paratype) has the cell M_3 (subdiscal) obtuse at apex and in this specimen the vein m_{3+4} is present, but weak. Although the bristles on the mesonotum in this species are extremely long, in the upper hind corner of the mesopleurae the bristle-like hairs, which are usually present in other species, are absent, there being only very soft white hairs in that area.

The distinctive characters of this species are:

Abdomen narrower than thorax, very elongated, regularly tapering towards the apex. Extremely long proboscis with narrow, nearly indistinguishable labella; antennae long, distinctly longer than head; 3rd antennal joint, which is at least as long as 2 basal joints combined, ellipsoid, but narrowed at base; palpi extending distinctly beyond the 2nd antennal joint; and 2 longitudinal narrow greyish irregular stripes on abdomen.

The author has also seen the following specimens:

WESTERN AUSTRALIA: 1 ♂, Nov., Swan Riv. (L. J. Newman); 1 ♂, 1 ♀, W. Aust.; 1 ♀, Geraldton (J. Clark).

Norris's description is quoted below:

"*Male*: Head about seven-tenths as high as wide. Eyes widely separated by slightly more than one-third of head-width, inner margins parallel. Head capsule black, completely covered with white tomentum except above antennal bases where there is a brown streak. Ocelli widely separated from eye and arranged almost in the form of an equilateral triangle. Median ocellus larger than others. Long, curling brown hairs extend from behind ocelli to the bases of the antennae, but are absent from the brown streak above-mentioned.

Antennae very long and slender, black. Basal segment dusted white, usually obliquely truncate distally when viewed from above, and concave on the inner surface; with long black bristles and proximally a few white hairs. Second segment globular, with white dusting and a whorl of about five long black bristles. Terminal segment cylindrical, with a silvery white dusting; style very short and blunt. The third segment crumples up on drying, and is longer than the basal. Antennae inserted a fair distance from epistome which forms a distinct apex below antennae.

Face very prominent. A fringe of white hairs round genae, partly concealing a prominent brown flange which projects and borders the epistome on either side.

Palpi slightly longer than antennae; light brown in colour; basal segment roughly cylindrical, with a few long white hairs. Second segment flattened distally, smoothly rounded at apex, with a few long white hairs proximally; most of the outer surface sparsely covered with black hairs. Pit small.

Proboscis black, very attenuated, labella very small, scarcely broader than body of proboscis in profile.

"Post-optic" bristles present in a tuft behind upper angle of eye, and extending in a row about half-way down the posterior margin of eye. Intermingled with these bristles are white hairs directed like the bristles radially outwards. On the lower aspect of the head capsule behind the eyes these white hairs become continuous with the fringe previously mentioned as running round the genae, and together with two long tufts from near the bases of the palpi hang down to form a long beard. Proboscis twice the length of antennae and three times the length of the head-capsule.

Thorax: Prothorax with black spines and white hairs above. Mesonotum black with three white stripes, the median of which is very slender, and separated from the broader, lateral pair by broad black bands. A white band continuous round edge of mesonotum, including scutellum. Mesonotum with a thin covering of fine brown hairs. Humeral callus with a tuft of short bristles. Lateral thoracic and scutellar bristles very long. Pleura black with white tomentum and a few white hairs, especially below wing and also above anterior coxae, where there is also a tuft of black bristles, though these may be white.

Legs brown, coxae with white tomentum and hairs, and white bristles. Wings rather small hyaline, free part of M_{3+4} may be absent. Halters brown.

Abdomen: Ground colour brown, darker at bases of segments. The four basal segments with paired white stripes above, separated by a continuous median black stripe. The white stripes may not extend over the anterior half of the tergites. The basal tergites are white laterally. Sternites of anterior region with white tomentum and a few white hairs. Basal tergite with white hairs and paired lateral tufts of black bristles. Distal segments and terminalia brownish black, with black bristles. Shape of terminalia similar to that in *A. minor* n. sp., but clasper differs in having no stout black spines ventrally.

Female: Larger than the male. Front of same width.

Measurements: Male, body 12 mm., wing 7 mm. Female, body 13 mm., wing 8 mm. Width of male thorax 2½ mm., of female thorax 3 mm.

Hab.: Gnangara, W.A., 2 females, 1 male, November, 1930, O'Connor. Gnangara, W.A., 2 females, November, 1930, Perry. King's Park, Perth, W.A., 4 males, 1 female, November, December, 1935, K. R. Norris."

8. APIOCERA VESPERA, sp. nov. ♂

More closely related to *A. mackerrasi*, sp. nov. than to others of the *A. minor* group.

Proboscis in proportion similar to *A. mackerrasi*; labella a little shorter, but distinctly broader than proboscis. Palpi as in *A. mackerrasi*, but a little shorter and black-haired. Hairs on face and lower part of head not such a pure white as in *A. mackerrasi*. A well-marked brownish stripe on middle of frons. Vertex twice as broad as ocellar triangle (in *A. mackerrasi* 3 times as broad).

Markings on mesonotum very different from those of *A. mackerrasi*: the middle brown stripe is divided by a central greyish stripe into 2 parts; 2 sublateral brown stripes are not complete as in *A. mackerrasi*, but distinctly broken. Ventral side of thorax covered with white hairs, not such a pure white as in *A. mackerrasi*, and at base of anterior coxae there is a tuft of black bristles. Halteres yellow. Wings as in *A. mackerrasi*, but subdiscal cell shorter.

Grey cross bands on hind margin of basal tergites more developed than in *A. mackerrasi*.

Length of body 12 mm, of wing 6.5 mm.

1 ♂, Oct. 1932, Booanya, W. Australia (Miss Baesjou). Type in South Australian Museum, Adelaide.

III. *Apiocera immedia* group

Despite all efforts the author cannot group this species with any others because of lack of details in the original description. It is possible that it belongs to *A. tonnoiri* group. Only when all of the *Apiocera* species in the Sydney area are well known will it be possible to decide where Hardy's species belongs.

9. Apiocera immedia Hardy ♂, ♀

Hardy, 1940, Proc. Linn. Soc. N.S.W. **65**: 484.

Hardy, 1921, Proc. Linn. Soc. N.S.W. **46**: 296, fig. **16**. *Apiocera* sp.

Among the material available to the author he cannot recognize this species. Hardy described it as follows:

"This very distinctive species is readily distinguished by the characters given in the key. It is of a deep shining chocolate-brown colour and without the white median thoracic line recorded on *A. vulpes* Herm. and occurring on all the others given below. A pair of slender white stripes reaches the transverse suture, and may be traceable to a pair of white spots placed just before the apical margin. Laterally another pair of white stripes reaches the transverse suture, slightly interrupted at the margin of the humeral callus, followed by 2 pairs of white spots, one above the wing insertions, the other on the postalar callus, reaching the scutellum, which is without visible marks. On the male the abdomen has a pair of white spots overlapping insertions at the apex of the 3rd to 6th segments; on the female similarly marked on the 1st to 4th segments. Head, pleura, and venter normal, as on *A. asilica*. This is the only species I have seen that has a tendency for the whitish markings to become yellow, as against the ashy white colouring of the others.

Length 24-26 mm.

Hab.: N.S. Wales, Sydney, 1 ♂, 2 ♀ ♀, 26th December, 1918; probably from La Perouse."

The following lines can be extracted from Hardy's key: "Black or brown species. Summit much narrower, less than 40% of total head-width. Frons broadening from summit towards antennae. Eye-summit-eye proportion on male 3:1:3 (14%), and on female 11:10:11 (31%). A broad central stripe of brown on the thorax is entirely without a median white line, and the whole insect is of chocolate-brown colour with markings otherwise not unlike those of *asilica*. Antennae and proboscis reach about the same distance and the palpi reach to the labellum."

Figure 16 of Hardy (1921) shows that labella is broad, occupying approximately 1/3 of whole length of proboscis; apical palpal joint slightly curved, at apex only a little broader than at base, at apex itself nearly rectangular.

All efforts to locate the types were fruitless. The author can only say that: (1) They were apparently not labelled and the type not fixed, (2) Mr. Hardy cannot remember where they were placed, (3) Among material available from the most important Australian collections the author has not found this species. It is probable that the types are lost.

IV. *Apiocera deforma* group

This group includes 6 species: *A. deforma* Norr., *A. maxima*, sp. nov., *A. goerlingi*, sp. nov., *A. elegans*, sp. nov., *A. pulchra*, sp. nov., and *A. helenae*, sp. nov. It is clearly defined from the other groups.

The wings as a rule are not hyaline as in most of the *Apiocera* groups, but slightly yellowish or blackish, with a large alula, which is much bigger than the triangular cell. The subdiscal cell is comparatively very large, broadly touching the lower basal cell, and nearly as long as the discal cell.

They are large and stout species, with the body mostly deep black or yellow shining. Male genitalia usually very swollen, large and massive, the upper forceps hanging over the lower ones. The mesopleurae are poorly haired, and there are no pairs of greyish triangles centrally on the tergites.

10. APIOCERA DEFORMA Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. **22**: 54.

Norris's description is quoted:

"*Male*: Head: Height three-quarters of width; ground-colour black. Eyes larger than the average, separated from paired ocelli by a distance equal to the breadth of the median ocellus. Separation of eyes at vertex three-fourteenths of head-width. Paired ocelli on the sides of a prominent tubercle separated from the eyes by deep grooves which unite on the occiput to form a V-shaped mark above the neck. Median ocellus situated in front of paired ocelli at a distance equal to twice the distance between the latter. Front depressed. Ocellar region with black tomentum and a coating of short, black, forwardly-curved hairs. These extend only a short distance in front of ocelli where the tomentum of the front becomes white, and the black hairs are replaced by longer and thinner white ones, extending to near the bases of the antennae.

Antennae short, light brown in colour; basal segment with a considerable bulge on the lower surface. This segment has a slight white tomentose covering and has a coating of long soft white hairs. Diameter of second segment greater than its length; with a few white hairs similar to those of basal segment. Third segment dilated, asymmetrical in profile. Style distinct, large. Third segment longer than basal, second segment about one-third its length.

Palpi about one-half as long again as antennae, dark brown in colour. Proximal segment cylindrical with sparse covering of long white hairs below. Second segment the longer, flattened distally, narrow and pointed apically, with a few short white hairs and a row of three or four pits on the outer face.

Proboscis black, twice head length, two and a half times the length of the antennae. Folded labella pointed apically.

Posterior aspect of head with white tomentum. "Post-optic" bristles present, fairly numerous, not extending down posterior margin of eye. White hairs extend in an irregular row parallel to posterior margin of eye, not, however, extending far enough upwards to intermingle with the black bristles above. Two tufts of white hairs behind the insertions of the palpi.

Thorax: Pronotum with white hairs and spines but no black bristles above. Mesonotum black, evenly coated with short black hairs; indications of two faint wedges at anterior end. A white band round the margin as in other species, extending onto sides of scutellum. Pleura dark brown with white tomentum and black and white hairs irregularly scattered.

Legs brown, coxae with white hairs, but devoid of black bristles.

Wings evenly tinted pale brown.

Abdomen stout, ground colour brownish-black. Basal segment with white tomentum and white hairs. A white band on posterior margin of second, third and fourth tergites, extending at sides on to succeeding tergites. Fifth segment almost all white. Following this the sclerites are mainly brownish-black. Venter mostly with white tomentum, but in large patches the brown ground colour is visible.

Terminalia very prominent and swollen. Superior edge of upper forceps with an apex near posterior end. Lower forceps considerably shorter than upper, blunt. Ninth sternite almost as long as lower forceps. Proctiger projecting behind teeth of upper forceps; lateral lamellae narrow, down-curved at tips, lower lamella broad, with a corresponding curve. Tip of upper forceps has soft white hairs but remainder of terminalia more or less densely covered with a coating of black bristles. Claspers unique, being in the form of broad, poorly chitinised plates, light brown in colour tapering rather abruptly distally, and with a slight pubescence.

Female: No female is available for description, but it should, however, be readily recognised by head characters and tinting of wings.

Measurements: Male, body 20 mm. (not including head). Wing 12 mm.

Hab.: Gnangara, W.A., 2 males, O'Connor, December. Swan River, W.A., 1 male, L. J. Newman."

Norris described only the male, and the female has not been recorded. However, it seems that 1 female from Midland, W.A., taken by Mr. A. N. Burns, 27.xii.1947, belongs to this species.

Female (new)

It differs from other females and males of this group by the dark ground colour of its tergites; only the conjunctive membrane at hind margin may be yellow; first 3 tergites dusted with yellow, but not densely, and ground colour is not masked by dusting. It is very characteristic (in both sexes) that in profile the mouth cavity is not visible (in other species the narrow cheeks are always visible). On apex of face and a little inside mouth cavity there is a tuft of yellowish hairs, which is also present in *A. pulchra*, sp. nov., but not in other species. In this species and in *A. pulchra* the grooves between ocellar triangle and eyes are very deep (as in Asilidae); ocellar triangle elongated, but its length is ½ distance between antennae and anterior ocellus (this applies also in *A. pulchra*). Vertex distinctly narrower than 1/3 of head width. Ocellar triangle occupies a little more than 1/3 of vertex. Third antennal joint nearly pear-like, distinguishing it clearly from that of *A. pulchra,* in which species it is tapering and hook-like in profile.

Mesonotum only with traces of longitudinal whitish stripes (they are developed well only at anterior border). Lateral whitish stripes from alar callus (including it) to base of wing are well developed. Two pairs of dorsocentral bristles in front of scutellum. Legs black, tarsi paler. Bristles on coxae whitish. Halteres yellow.

Wings distinctly and evenly suffused with brown. Veins m_1 and r_5 running nearly parallel, but at costa suddenly converging.

Last 3 segments of abdomen with short, erect dark hairs, directed slightly towards base of abdomen. Whole abdomen dark, dull, with yellowish dust on 1st 3 tergites, but dusting does not mask the ground colour.

11. APIOCERA MAXIMA, sp. nov. ♂, ♀

Ground colour of body black, but the tergites are always (particularly on middle line) more or less broadly yellow and the sternites are also partly yellow. Head very densely dusted with yellow. All hairs and bristles on head and its parts yellowish, only on ocellar triangle and along inner margin of eyes there are short, sparse, black hairs. Vertex in male about 1/7, in female 1/5 of head width. Proboscis short, protruding beyond apex of antennae only for ½ the length of labella; labella large, only a little shorter than proboscis itself. Palpi long, protruding to the apex of 2nd antennal joint; 1st joint narrow, 2nd nearly egg-shaped, very broad, nearly 4 times broader than 1st, reaching the base of labella. Ground colour of antennae variable, dark or yellow. Antennae short, equal in length to head; 2nd joint flattened, broader than long, nearly 1/3 length of 1st and ¼ length of 3rd; the latter is nearly egg-shaped, with a small appendix on tip.

Mesonotum dark, very densely and regularly covered with yellowish dusting, the microscopic hairs are black; on side of mesonotum over humeral calli, notopleural depression, and supra-alar area a broad whitish stripe extends to the scutellum; this stripe is bordered above and below by 2 smaller brown stripes. Bristles on mesonotum and scutellum very well developed; in notopleural row about 12 bristles, on hind margin of scutellum more than 4; there are a pair of dorsocentral bristles and some smaller ones. Sides of thorax very densely whitish dusted.

Wings hyaline, with a distinct yellow tinge overall. Ambient vein present along the hind border to the apex of anal cell. Venation normal, all veins strong; cell M_3 (subdiscal cell) only a little shorter than discal cell; all veins yellow. Halteres yellow. Femora black, tibiae and tarsi mostly reddish, but there are specimens also with dark tibiae. Coxae dark, with whitish bristles.

Ground colour of tergites variable, but as a rule the last 4 tergites are reddish yellow; hypopygium of male black. On the sides of 2nd to 4th tergites there are 3 broad, slightly oblique, nearly vertical, black bands, separated from one another by white bands; sides of 5th and 6th tergites are entirely dusted with white and haired; black and white colours very contrasting. In female the 3 black stripes are poorly developed. Dusting on tergites yellow, very dense; hairs on abdomen black, microscopic, except on 1st tergite, which has long, dense, yellowish ones. On hind margin of this tergite there are black thin bristles. Sternites mostly black, with narrow, yellow posterior margin.

Hypopygium of male very long, ½ as long as thorax. Upper forceps distinctly longer than the lower ones, overhanging the lower as a roof (tectiform).

Length of body 22-27 mm, of wing 15-21 mm.

VICTORIA: 1 ♂, Mallee, Jan. 1915 (type); 1 ♂, Geelong (H. W. Davey). WESTERN AUSTRALIA: 1 ♂, 2 ♀♀. SOUTH AUSTRALIA: 1 ♂, 2 ♀♀, S. Aust.; 1 ♀, Purnong.

Type in National Museum, Melbourne.

12. APIOCERA GOERLINGI, sp. nov. ♂, ♀

Very similar to *A. maxima*, sp. nov., but readily distinguished by the characters set out in the key.

Antennae, tibiae, and tarsi bright yellow. Yellow dusting of mesonotum so dense that ground colour is masked very well (in *A. maxima* the black ground colour is much more visible). Stripe of white dusting on the sides of mesonotum absent, as also is the narrow brown stripe along notopleural bristles, formed mostly by dark hairs between them.

Whole abdomen in male yellow, except for 3 vertical broad black fasciae on the sides of 2nd, 3rd, and 5th tergites: in female the sides of 1st to 4th tergites are black; the 1st and 2nd sternites are also black.

Length of body 26-28 mm, of wing 18-22 mm.

WESTERN AUSTRALIA: 1 ♂, 1 ♀, Pinjarra (E. Goerling); 1 ♂, 2 ♀♀, Mt. Jackson.

Types in Division of Entomology Museum, C.S.I.R.O., Canberra.

13. APIOCERA ELEGANS, sp. nov. ♂

This species is very easily distinguished from others in the *A. deforma* group; it is closely related to *A. maxima*.

Head black. Proboscis black, protruding beyond the antennae, labella large, occupying 1/3 of whole proboscis. Basal palpal joint brownish, apical yellowish, both sparsely covered with yellowish hairs. Palpi extending beyond the apex of 2nd antennal joint: apical joint very elongated, nearly straight, elliptical, rounded at apex, twice as broad as at base. Antennae very short, 2 basal joints brownish, 3rd bright yellow, more or less pear-shaped, but a little asymmetrical. Antennal bristles yellowish. Occiput yellowish dusted, with yellowish bristles. Face and frons whitish yellow dusted, frons with whitish yellow hairs. Vertex occupying approximately 1/5 of head width. Grooves between ocellar triangle and eyes very deep; ocellar triangle elongated; distance from anterior ocellus to antennae is 1.5 times the length of ocellar triangle.

Thorax and scutellum black, shining, no stripes or other markings. Supra- and postalar bristles yellowish, the remainder dark. Four bristles on scutellum. Legs dark, but tibiae and tarsi yellow. Halteres yellow. Wings slightly yellowish, veins yellow. Vein *r-m* distinctly beyond the middle of discal cell. Alula very large.

First tergite black, with very narrow yellow transverse stripe at hind margin. Basal part of 2nd tergite black (a little less than ½ its length), apical part yellow, shining, boundary between 2 colours is rather sharp and in the centre there is a small acute black projection into the yellow part. Third and 4th tergites with similar disposition of colours, but without the black projection. Remainder of abdomen and genitalia red, shining. Hairs on abdomen extremely poorly developed, nearly absent. Sternites mostly yellowish red, only the bases of first 3 black. Hairs also practically absent on sternites. Genitalia very large; upper forceps only protruding a little beyond the tip of the lower ones, but their tip is on same level as that of lower forceps. Upper forceps form in their basal 2/3 a narrow, elliptical space, in apical 1/3 another much narrower space (in other species the latter is distinctly broader than the basal elliptical space). The 9th sternite is extremely large, extending 4/5 of the length of lower forceps, and covering nearly whole under side of genitalia. Hairs covering genitalia yellowish, but on under side of lower forceps there are numerous black bristles-hairs.

Length of body 24 mm, of wing 16.5 mm.

1 ♂, Cue, W.A. (H. W. Brown). Type in South Australian Museum.

14. APIOCERA PULCHRA, sp. nov. ♂, ♀

This species differs in both sexes from other species of the *A. deforma* group by the bright orange, shining ground colour of the first 4 tergites. General ground colour of body is deep black, shining. Head with whitish dusting, sides of mouth cavity shining. Bristles and hairs mostly whitish or yellowish, but on occiput and on 2nd antennal joint there are some black bristles. Vertex in male occupying approximately ¼, in female 1/3 of head width.

Antennae black, except that 3rd joint may be a little reddish ventrally, a little longer than head. First joint cylindrical, 3 times longer than the short 2nd; 3rd joint broad, irregularly egg-shaped, its tip pointed and curved in very characteristic form; about as long as 2 basal joints combined. Proboscis about twice as long as head, broad (in profile), labella acute at apex and large. Palpi dark, extending to the labella; 1st palpal joint with long yellowish bristles, 2nd with similarly coloured, but short hairs; both palpal joints long, narrow, in female the 2nd is a little broader at apex, both forming a small arc (boomerang-like), in male the apical joint is broader in its apical portion and rounded at apex. Ocellar triangle is as long as ½ distance between base of antennae and anterior ocellus.

Mesonotum deep black, shining, without markings in male, in female with white dustings on humeral calli, anterior margin (2 short, wedge-like spots) and in lateral area. Hairs short, black; bristles numerous, strong, also black. Scutellum as a rule with 4 bristles. Sides of thorax black, shining, but in female there is anteriorly an oblique whitish-dusted band (behind the spiracle) and another band, extremely sharply marked, extends from the hind coxae to the sides of 1st tergite. Wings slightly darkened or suffused with yellow. Venation normal, but subdiscal cell very long, broad. Alula large. Vein *r-m* before or on middle of discal cell. Vein m_2 strong and long. Halteres yellow. Legs deep black, tibiae sometimes reddish translucent.

Abdomen conical, elongated, but rather broad. First 4 tergites bright orange, shining, as if polished, nearly bare, bordered at sides (viewed from above) with narrow black longitudinal stripes. Three last tergites and all sternites deep black, shining; in male the sides of 5th tergite with large white-dusted lateral spots, in female the sides of 1st, 2nd, and 3rd tergites with very dense pure white dusting and the ground colour is here only faint. Sides of 1st tergite with whitish hairs; other hairs black, microscopic; on hind margin of 1st tergite a row of small black bristles. Three last segments in female with dense, erect, black hairs directed slightly towards base of abdomen. Genitalia of male very large. Upper forceps, viewed in profile, are nearly rectangular at upper corner. Ninth sternite large, but not so massive as in *A. elegans*, sp. nov. Hairs on genitalia predominantly black.

Length of body 22 mm, of wing 16 mm.

WESTERN AUSTRALIA: 1 ♂, 14.xii. and 2 ♂ ♂, 24.xii.1947, Bullsbrook (A. N. Burns); 2 ♂ ♂, 2 ♀ ♀, "47-2218, 2219, 2220, 2221" (W.A. Museum); 1 ♀, Dec., Gnangara (O'Connor); 1 ♀, Mundaring (J. Clark); 2 ♂ ♂, 3 ♀ ♀, 28.xii.1947, Bullsbrook (D. C. Swan).

Type in the private collection of Mr. A. N. Burns, female in Department of Agriculture, W.A.

15. Apiocera helenae, sp. nov. ♂, ♀

Very closely related to *A. deforma*, but differs in having a dense yellow pulverulence, which covers in both sexes most of the surface of the basal 4 (♂) or 3 (♀) tergites (it is possible that the female of *A. deforma* described by the author above belongs to this species).

Two white wedges on anterior part of mesonotum very well developed in male, and in female there are 3 distinct white longitudinal stripes (in addition to the lateral), which almost reach the scutellum. Mesopleurae brown, with a pure white longitudinal stripe along the suture, which separates the mesonotum from mesopleurae, but the uppermost part of the mesopleurae near the suture is dark, contrasting very sharply with white lateral stripe of mesonotum, and with the white, above-mentioned stripe of mesopleurae.

Very characteristic is the presence of fine, rather numerous whitish hairs of anterior margin and a little inside of the mouth cavity; these hairs are placed similarly to "moustache" of some asilids (only a tuft is present in *A. pulchra*); and their presence has not been detected in *A. deforma*.

Without specimens of *A. deforma* it is not possible to give more characters of difference. Size as in *A. deforma*.

4 ♂♂, 4 ♀♀, 28.xii.1947, Bullsbrook, W.A. (D. C. Swan).

The type (male) is in the Waite Institute, Adelaide; cotypes (♂, ♀) in Division of Entomology Museum, C.S.I.R.O., Canberra.

The author named this species in honour of Miss H. M. Cane, to whom he is indebted for the collection of many interesting flies.

V. *Apiocera omniflava* group

This group, which comprises only 4 species: *A. omniflava*, sp. nov., *A. afacialis*, sp. nov., *A. latipennis*, sp. nov., and *A. deserticola*, sp. nov., is very closely related to the *A. tonnoiri* group. Further study is necessary to decide whether it should be amalgamated with the *A. tonnoiri* group.

The ground colour of the body in this group is predominantly yellow or brownish, whilst in the *A. tonnoiri* group it is brown or blackish. The strong bristle (or 2-3) on the sclerite behind the mesopleura is absent in this group. Only females of the 4 species are known.

16. APIOCERA OMNIFLAVA, sp. nov. ♀

Differs from all other species in the leather-yellow ground colour of body and of all extremities. All hairs and bristles are yellow or reddish, and so are the veins of the wing.

Vertex distinctly narrower than eye, a little less than 3 times the width of ocellar triangle. Antennae very short; 1st joint twice as long as the 2nd, 3rd joint nearly as long as 2 basal joints combined, almost round, not pear-shaped. Yellow bristles on the lower side of 1st joint very thick, long and numerous. Proboscis short, projecting a little beyond apex of antennae. First palpal joint long, narrow, 2nd very broad, nearly egg-shaped, almost 4 times broader than the 1st.

Ocellar triangle comparatively short, but not equilateral, elongated, its length equal to ½ the distance between anterior ocellus and base of antennae.

Hairs on mesonotum microscopic. Two dorsocentral bristles on each side in front of scutellum. Alula very well developed. Vein m_1 very well developed, running parallel to the veins r_{4+5}, but before the apex abruptly curved to r_5; vein m_2 very weak, but long, running parallel to vein m_1 and reaching hind margin of wing. Discal cell is unusually short and broad, about as long as common stem of veins r_4 and r_5 (in *A. asilica* this stem is about ½ as long as the discal cell). Subdiscal cell is distinctly shorter than discal cell, at 1 point touching the lower basal cell.

Abdomen elongated, conical, without sharp contraction in second ½. Seventh segment with erect, dense hairs.

Length of body 19.5 mm, of wing 13.5 mm.

1 ♀, Oct. 1910, Bernier I., W.A. (Watson). Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

17. Apiocera afacialis, sp. nov. ♀

Closely related to *A. omniflava*, sp. nov. The yellow ground colour of the body, extremely large apical palpal joint, and absence of face, which is replaced by a very large mouth cavity, distinguish this species at once from the other groups and other species (partly).

Ground colour of body, including proboscis, eyes, and legs, reddish yellow; bristles on whole body the same colour. Veins on wings reddish yellow, slightly darkened towards the apex. Mouth cavity is deeply sunken in comparison with cheeks, which are very narrow, its apex distinctly reaches the bases of the antennae, in such a way that all central part of face is absent, being replaced by mouth cavity. Viewed from below the mouth cavity occupies more than 1/3 of head width. Proboscis projecting a little beyond apex of antennae, labella nearly as long as antennae, making an acute angle with the proboscis.

Apical joint of palpi very large, distinctly longer and broader in its apical ½ than the 3rd antennal joint. Antennae pear-like, in proportion very similar to *A. asilica*. Viewed in profile the 1st joint is very broad, as broad as the 3rd, and has on its whole ventral side a very dense row of yellow bristles, which form a large fan, on dorsal side the bristles are normal and not very dense. Vertex broad, about ¼ of head with; distance between ocelli and eyes distinctly greater than breadth of 1 ocellus (nearly double). Ocellar triangle elongated, viewed from front at same level as the highest point of the eyes.

Mesonotum like the whole body is rubbed, but it is evident that the hairs covering the body were not long and dense. Venation normal, but the vein m_{3+4} is very probably absent (the wings are not well preserved). Bristles along the costa at base of wing (pecten) reddish.

Abdomen narrow, elongated. Two last segments (6th and 7th) covered with erect hairs.

Length of body 18 mm, of wing 11.5 mm.

1 ♀, Daly River, N.T. (H. Wesselman). Type in the South Australian Museum.

Differs from *A. omniflava* in its much narrower head, which is only slightly broader than high. In *A. omniflava* it is nearly twice as broad as high. The ocellar triangle is at the same level as the highest point of the eyes (viewed from front), while in *A. omniflava* it is distinctly higher. The eyes are reddish, in *A. omniflava* black. The 3rd antennal joint is more pear-like, in *A. omniflava* it is nearly round. The vertex is shorter than the ocellar triangle, in *A. omniflava* the converse applies. The 6th and 7th tergites have erect hairs, in *A. omniflava* only the 7th tergite has erect hairs, and the 6th has depressed hairs. In general *A. omniflava* is larger and stouter.

18. Apiocera latipennis, sp. nov. ♀

Readily distinguished from *A. deserticola,* sp. nov., by the characters given in the key.

Apical part of 1st antennal joint, whole 2nd and 3rd joints deep black, basal part of 1st paler, reddish; 3rd joint more elongated than in *A. deserticola.* Veins dark. Wings very broad, with very large alula and axillary cell. Second, 3rd, and 4th tergites with 2 longitudinal greyish submedian stripes, very widely separated by a median brownish stripe.

Length of body 20 mm, of wing 16 mm.

1 ♀, Dec. 1916, Chapman River, W.A. Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

19. Apiocera deserticola, sp. nov. ♀

Ground colour of body yellowish brown. Antennae short, yellow, 3rd joint pear-like, but of short form, bristles yellowish. Proboscis short, extending a little beyond apex of antennae or even shorter; labella large, a little longer than the remainder of proboscis. Palpi yellowish, not reaching the apex of 1st joint of antennae, apical joint broad, nearly egg-like. Vertex very broad, occupying more than 1/3 of head width; ocellar triangle a little less than 1/3 of vertex in width. Ocellar triangle a little elongated; distance between the anterior ocellus and antennae nearly twice as long as triangle. Grooves between ocellar triangle and eyes very deep. Upper part of frons brownish, lower whitish. Occipital bristles yellow. Inner margin of eyes slightly divergent from vertex to lower points of eyes; the face is extremely broad in the mouth area. Head whitish dusted, with yellowish hairs.

Mesonotum yellowish dusted, with 2 parallel-sided brownish, longitudinal submedian stripes, relatively narrow; the yellowish median stripe which divides these is a little broader than they are; inside from humeral calli there are 2 small brown triangles. In general the mesonotum is almost uniformly yellowish and the brownish striping is not very well developed. Hairs on mesonotum extremely short, bristles rather long and strong, brown.

The peculiarity of this group is the presence of 1 very strong bristle at the sides immediately behind the notopleural depression in the suture itself (in all other groups there is a bristle rather far behind the suture). Sides of thorax nearly bare, dusted with white. Halteres and legs yellow, but long bristles on legs black, bristles on coxae yellowish.

Wings hyaline. Ambient vein and vein m_{3+4} absent; vein m_2 extremely long, weak, at least 2/3 as long as vein m_1. Alula well developed.

Abdomen conical, 1st tergites dusted with yellow, the remainder slightly shining. In the middle of 2nd and 3rd tergites there is a rather indistinct brownish cross band. Sixth and 7th segments with black, short, erect hairs.

Length of body 20 mm, of wing 13.5 mm.

1 ♀, Pinjarra, W.A. (E. Goerling); 1 ♀, Ooldea, S.A. (A. M. Lea).

Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

VI. *Apiocera tonnoiri* group

A group of 6 species: *A. tonnoiri* Norr., *A. campbelli*, sp. nov., *A. oblonga*, sp. nov., *A. norrisiana*, sp. nov., *A. imminuta* Hardy, and *A. norrisi* Hardy, which probably includes species now placed in the *A. omniflava* group.

Species of this group have the abdomen uniformly coloured, without the greyish triangles so typical in *A. asilica* and other groups. The mesopleurae are poorly haired. The vertex in the male is extremely narrow, often narrower than the ocellar triangle. The abdomen in both sexes is very elongated, conical, without a sharp constriction at 5th segment. Proboscis always short. Subdiscal cell always very well developed, connected usually with hind margin by m_{3+4}. Sclerite behind the mesopleura always with 1-3 comparatively strong bristles at the upper corner. Palpi mostly short, the apical joint usually very acute at the lower angle.

20. APIOCERA TONNOIRI Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. 22: 57.

Norris's description is as follows:

"A large elongated species very distinctive in character of proboscis.

Male: Head very concave posteriorly. Front depressed. Face not projecting. Head-height about nine-elevenths of width. Eyes large, separated at vertex by only twenty-second part of head width. A very deep narrow groove runs between eyes at vertex behind ocelli, and continues out on to occiput to run in a much shallower form into cervicum. Ocelli crowded forwards from normal position. Paired ocelli practically touching eyes, and elongated in a vertical direction. Median ocellus larger, transversely oval, well separated from others. Ocellar tubercle and front with long black hairs. Face and oral margins with white tomentum.

Antennae situated almost on epistome. Basal segment light brown, very convex ventro-laterally; with white tomentum and long, black and white hairs. Second segment brown, shorter than broad, dusted with white and with long black bristles round middle. Third segment light brown, darker distally; with faint white dusting. This segment is slightly longer than the first. Style black.

Palpi honey-coloured, both segments darker at base. Proximal segment the longer, cylindrical, dusted with white, and with white hairs. Distal segment shaped like a quart of an orange, dusted with white and with a coating of long white hairs, and one or two black ones. Pit prominent, situated slightly nearer to base than to apex.

Proboscis brown with very characteristic labella slightly less than one and a half times the length of the head capsule. Occiput with dense white tomentum, a ruff of short white hairs, and a small tuft of black bristles behind each eye apex. Hairs round edge of oral cavity white, extremely short. All white hairs round edge of occiput and near bases of palpi are exceptionally short.

Thorax dark brown, entirely pollenose. Pronotum white pollenose, with white hairs and a circlet of black bristles. Mesonotum with a slender median stripe, dirty-white in colour. A pair of stripes flanking this, broadening anteriorly. Humeral callus and a lateral longitudinal stripe behind this white. Lateral and scutellar bristles black. Rest of dorsum with a sooty-brown pollen. Dorsum of thorax with a dense coating of short dark brown hairs. A patch of white hairs on post-alar callus and above wing-base. Scutellum with a sparse coat of white hairs which extend beyond its limits on to posterior part of scutum. Post-scutellum white pollenose. Pleurae brown, entirely covered with white tomentum; in patches with very short black hairs.

Wings hyaline, veins black.

Legs light brown, tomentum white, but sparser distally. Bristles black. Soft white hairs on coxae and bases of femora.

Abdomen long and tapering. Ground colour brown. Basal tergites with a sooty coloured pollen, except at lateral margins, which are white; with a dense coat of fine white hairs, and, on basal tergite, a few black ones. The four tergites lack this hairy covering. Sternites with sparse white tomentum and white hairs.

Terminalia dusted with white. Proctiger with lamellae separated at tips. A dense beard of long white bristles closes cavity from below. Eighth sternite very prominent, whilst ninth sternite which bears the abovementioned beard is in the form of a truncate plate. Clasper, Plate 2, b.

Female: Very similar to male but eyes more widely separated at vertex, i.e. by two-ninths of head width. Distance between each lateral ocellus and eye is equal to that between the members of the pair. On account of genitalia, abdomen appears shorter.

Measurements: Male, body 20 mm., wing 13 mm. Female, body 18½ mm., wing 14 mm.

Hab.: Applecross (about 5 miles east of Fremantle), 12 males, 10 females, February 1935, December 1935, February 1936. K. R. Norris.

The Writer has taken this species at only one locality. The flies occurred round bushes of the Protaeceous plant *Adenanthos cygnorum*. For the most part they rested on the loose sand, but occasionally specimens were seen flying and climbing in the branches of the abovementioned shrub, the extrafloral nectaries of which are, no doubt, the attractive agent. In flight the sound produced resembles that of a large blowfly.

Although within a few paces there were abundant flowering shrubs of pink myrtle (*Hypocalymma robusta*) the flies were never on any occasion observed to visit it although dozens of species of Diptera and other insects were taken on this plant, including a species of *Neorhaphiomidas* gen. nov."

The author has seen the types of this very distinct species, and two additional specimens: 1 ♂, 1 ♀, Swan River, W.A. (L. J. Newman).

By description of *A. campbelli*, sp. nov., *A. oblonga*, sp. nov., and *A. norrisiana*, sp. nov., the author has mentioned some new characters of this species.

21. APIOCERA CAMPBELLI, sp. nov. ♂

Very similar to *A. tonnoiri*, but very easily distinguished by the characters outlined in the key.

Frons with yellowish hairs (in *A. tonnoiri* with brown hairs). The long fine hairs in middle of 1st, 2nd, 3rd, and 4th tergites are brownish (not white as in *A. tonnoiri*). Space between the upper forceps basally very narrow, in the apical ½ it is widened, but very regularly (in *A. tonnoiri* it is apically much broader and the widening is sharply marked, not regularly). In upper hind corner of mesopleurae there are, as in other species of this group, 2 or 3 black bristles. Bristles on coxae whitish, not black as in *A. tonnoiri*. Ninth sternite very long and narrow, ½ as long as lower forceps, space between lower forceps in apical ½ as broad as 9th sternite, parallel-sided (in *A. tonnoiri* the 9th sternite is broad, quadrangular, nearly quadratic; space between lower forceps in apical part is extremely broad and not parallel-sided); and there are other important characters of difference in genitalia. Size as in *A. tonnoiri*.

2 ♂ ♂, 28.ix.1933, Brocks Creek, N.T. (T. G. Campbell).

Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

22. Apiocera oblonga, sp. nov. ♂, ♀

An intermediate form in the group, between *A. tonnoiri* and *A. imminuta*.

Male

Vertex broader than in other species of this group, but not quite as broad as ocellar triangle. Proboscis and labella as in *A. norrisiana*, sp. nov.

Thorax is in comparison with all other species of *Apiocera* (excepting perhaps only *A. imminuta*), very narrow, a little broader than abdomen, which is also very narrow. White striping of mesonotum is poorly developed, only lateral stripes being broad and very well marked. Some black bristles in hind upper corner of mesopleurae.

Abdomen narrower than the head. Fourth tergite without black bristles laterally (they are well developed in *A. tonnoiri*). Abdomen without white markings, but hind margins of tergites a little paler. Genitalia extremely characteristic: they are very long, as long as the 3 last segments; 8th sternite distinctly longer than 8th tergite, but not as long as in *A. tonnoiri* and others of group; structure of lower forceps is quite abnormal; they are extremely broad, viewed in profile many times broader than the upper forceps. Ninth sternite narrow, triangular, equal to approximately 1/3 of forceps length. Lower forceps at apex not convergent as in other species, but divergent; touching the 9th sternite, therefore the open space around it is absent.

Female

Very similar to the male. Vertex a little narrower than eye. Only last segment (and penultimate sternite) with erect, short, dense hairs. Dorsal side of abdomen (viewed from above) uniformly brown, ventral side whitish, with sharply marked boundary.

Length of body 16-17 mm, of wing 10 mm.

1 ♂, 1 ♀, 24.xii.1934, Lesmurdie, W.A. (K. R. Norris); 1 ♂, labelled "University coll." (Perth) (K. R. Norris). Types now in Division of Entomology Museum, C.S.I.R.O., Canberra.

Mr. K. R. Norris has kindly informed the author: "This species was collected in a farmlet, where small myrtaceous shrubs were in flower. One specimen was removed from a spider web."

23. APIOCERA NORRISIANA, sp. nov. ♂, ♀

Male

Vertex narrower than posterior ocellus. Proboscis very short, thick, not reaching apex of antennae, labella thick, not forming a large angle with the proboscis, but extending in same direction as the proboscis (very good character to distinguish it from *A. tonnoiri*).

Mesonotum and scutellum dark brown, laterally mesonotum with broad, white, very well-developed longitudinal stripes, extending from anterior margin of scutellum and including its sides; these stripes becoming broader towards the end. Anterior part of mesonotum with 3 very narrow, white, poorly developed stripes, which reach only to middle of mesonotum. White lateral stripes can be seen particularly well from the side (in *A. tonnoiri* they are nearly absent).

Halteres, wings, legs as in *A. tonnoiri.*

Abdomen dark brown dorsally, without white spots or stripes (as in *A. tonnoiri*); sometimes hind border of 2nd, 3rd, and 4th tergites is fringed very narrowly with white, but this colour is not very easily seen. Lateral parts of tergites curved towards sternites are white. Ninth sternite extremely broad, tetragonal, covering nearly all under side of genitalia, twice as long as wide; it is nearly equal to ½ of lower forceps length; its apical margin is covered with very long yellowish bristles-hairs. Lower forceps extremely narrow (viewed from below and in profile), particularly in distal ½, slightly curved. In comparison with *A. oblonga,* sp. nov., this species is quite opposite in structure of genitalia. Upper forceps with a large space between them, particularly in apical part, where this space is lanceolate. If insect is examined laterally there is a strong contrast between the dark brown surface of the tergites and whitish of the sternites.

Female

Differs from the male rather markedly in the ground colour of its body, which is chocolate, and by much broader, regularly conical abdomen etc.

Head and its parts as in male, but vertex is comparatively very narrow, occupying 1/5 of head width; ocellar triangle placed very far from hind margin of eye.

Thorax and abdomen as in male, but there are traces of yellowish striping on mesonotum, and abdomen has more yellow dusting.

Length of body 20-22 mm, of wing 12-13 mm.

WESTERN AUSTRALIA: 2 ♂♂, 12.i.1942, Nedlands (K. R. Norris); 3 ♂♂, 20, 21, and 2 ♂♂, 28.i.1934, 1 ♀, 8.ii.1936, Crawley (K. R. Norris); 1 ♂, 29.ix.1933, Cottesloe, (M. Solomon); 1 ♂, Cottesloe (W.A. Museum); 1 ♂, Swan R. (L. J. Newman); 1 ♀, Perth (W.A. Museum).

Types in Division of Entomology Museum, C.S.I.R.O., Canberra.

Mr. K. R. Norris had kindly informed the author: "The series of *A. norrisiana* was collected in King's Park, Perth, near the Biology Department of the University, where they frequented the open sandy pathways. Unlike *A. tonnoiri* this species appears to have no specific attraction to the plant *Adenanthos cygnorum.*"

24. APIOCERA IMMINUTA Hardy ♂, ♀

Hardy, 1940, Proc. Linn. Soc. N.S.W. **65**: 489.

This species and *A. oblonga* more or less comprise a small subgroup.

Male

Sides of thorax nearly bare, with only 2 black bristles and some hairs in upper hind corner of mesopleurae. Body long, very narrow, *A. oblonga* being very similar in this respect. Proboscis extremely short, reaching only to apex of 2nd antennal joint. Labella as long as remainder of proboscis. Palpi extremely characteristic, very short, nearly pure white; apical joint irregularly egg-shaped, slightly pointed at the apex on under side. Ocellar triangle only slightly elongated, distance from anterior ocellus to antennae nearly twice as great as length of ocellar triangle. Ambient vein absent, veins m_1, m_2, m_{3+4} very weak, but always present and reaching hind margin of wing. Bristles on mesonotum and scutellum very long and strong. As a rule 4 bristles on scutellum. Longitudinal striping of mesonotum very clearly visible: 3 broad, brown stripes (the median is divided by 1 very small, yellow) and 4 whitish. Basal tergites with whitish narrow cross bands or pair of transverse triangles at hind margin. Genitalia rather short; 9th sternite very characteristic, almost invisible; inner margins of lower forceps are almost straight, not excavated as in most other species, and not forming a broad elliptical or heart-like space.

Female

Superficially very different from male because of its chocolate ground colour and rather broad conical abdomen, but venation, structure of proboscis, palpi, antennae, and other characters are similar.

Vertex a little broader than 1/3 of head width. Antennae short, typical; bristles on upper side black, on under side whitish. Head whitish dusted. Frons with black hairs. Bristles on occiput black. Face and frons with nearly parallel sides, very broad, much greater than 1/3 of head width, but a little narrower at vertex.

Mesonotum striped as in male, sides of thorax nearly bare, whitish dusted. Venation as in male, vein *r-m* short, point-like, situated a little beyond the middle of discal cell (in male also). Halteres yellow; legs yellow (in male dark). Three last segments with black, dense, erect hairs. Viewed from above abdomen is brown, but ventral side including lateral parts of tergites whitish, the boundary between these colours being sharp and nearly straight. Four basal tergites have 2 broad submedian longitudinal stripes a little paler in colour than at sides and in the middle.

Length of body 14-20 mm. of wings 9-13 mm. The females are on the average larger than the males.

NEW SOUTH WALES: 1 ♀, Jan. 1915, 1 ♂, 15.xii.1924, Sydney; 1 ♂, 26.xii.1925, Sydney; 3 ♂♂, 1 ♀, 11.xii.1925, Kurnell (Mackerras); 2 ♂♂, 2 ♀♀, 3.i., 26.i.1932, Cronulla, near Sydney (G. G. Gay); 1 ♂, 1 ♀, Jan. 1924, Broken Bay, near Sydney (Mackerras). QUEENSLAND: 1 ♂, 3.xii.1912, 1 ♂, 5.xii.1913, Stradbroke I. (H. Hacker); 7 ♂♂, 2 ♀♀, 10.i.-6.ii.1947, Tugun (K. R. Norris).

The paratype (♀) is in the Division of Entomology Museum, C.S.I.R.O., Canberra.

25. APIOCERA NORRISI Hardy ♂, ♀

Hardy, 1940, Proc. Linn. Soc. N.S.W. **65**: 490.

Hardy described this species as follows:

"The markings are as on *A. imminuta*, the head is normal and the proboscis is slightly longer than twice the head length, extending well beyond the antennae. The characters given in the key are ample for recognition of the species and, in addition, the wing has the first and second median veins weakened and white but complete, whereas the third and fourth median veins meet as usual, but do not continue, so the united part which normally runs to the wing margin is absent. Length, 12 to 13 mm.

Hab.—Queensland: Mungindi, 1 ♂, 3 ♀, all found resting on twigs at sundown, six miles north, along the Dareel road on red soil country. The species looked very much like an *Anabarrhynchus* (Therevidae) for which it was mistaken when seen in flight, earlier in the day, over the adjacent paddock infested with *Bassia Birchii* (Chenopodiaceae)."

The following additional characters can be extracted from Hardy's key: Thorax with a median white line, making 4 dark and 5 whitish stripes. Abdominal markings reduced to white along the posterior margin of the segments.

Distinctive characters of this group are: The yellow or brown body colour, bare sides of thorax, absence of ambient vein and vein m_{3+4}, comparatively short and thin proboscis, the presence of a very strong black bristle behind the notopleural depression nearly in the suture (in other *Apiocera* species this bristle is placed well away from the suture).

The author has seen specimens from the following localities: 2 ♂♂, 3 ♀♀, 18.i.-12.ii.1931, Chumooli, near Wyndham, W.A. (H. T. Willings); 1 ♀, 27.i.1930 (T. G. Campbell) (no locality).

VII. *Apiocera hardyi* group

This group includes 3 species: *A. hardyi hardyi,* subsp. nov., *A. hardyi angustifrons,* subsp. nov., *A. fullerae,* sp. nov., and *A. nicholsoni,* sp. nov., but probably some undescribed species would also be placed here. The material is not well preserved and the specimens too rubbed for description.

It is closely related to the *A. asilica* group (sens. lat.), and differs only in the sharply marked longitudinal stripes on the mesonotum and abdomen; the stripes are usually parallel-sided.

The author has collected *A. hardyi* on flowers of *Leptospermum.* It is rather common in the Canberra area. This group is poorly represented in most Australian collections.

26. Apiocera hardyi, sp. nov. ♂, ♀

Male

Vertex comparatively broad, occupying almost ¼ of head width; ocellar triangle long, occupying a little more than ½ of vertex; distance between the eye and posterior ocellus distinctly more than width of the latter. Proboscis moderately long, extending beyond the labella; labella large, nearly ½ as long as proboscis. Palpi yellow, rather long, nearly reaching the labella; apical joint is distinctly curved downwards, broadly rounded at apex, more than twice as broad as at base. Antennae short, nearly as long as head, yellowish, with dark and strong bristles on 2 basal joints; 3rd joint typically pear-shaped with a short appendix at tip.

Whole head is densely dusted with white, with whitish hairs, and on occiput yellowish bristles; hairs on ocellar triangle brownish. Mesonotum with 3 very distinct, longitudinal, brown stripes; the median stripe is divided into 2 by a much narrower central yellowish stripe, not reaching the scutellum, but extending about ¾ of the length of the mesonotum. The median brown stripe slightly narrower in front of the scutellum, extends over the latter and further to the apex of abdomen. The 2 sublateral brown stripes broad, well marked, irregular, but always uninterrupted, extend only to the scutellum. Hairs on mesonotum greyish and brownish; on sides of thorax greyish, dense, and long. Two lateral greyish or yellowish stripes broader than the other and also extend to the scutellum. Bristles on mesonotum numerous, black, strong; 4 bristles on scutellum.

Wings hyaline, venation normal; alula well developed; halteres yellow. Legs yellowish brown; tarsi dark.

Abdomen dorsally has 3 brown (1 median, 2 lateral) and 2 greyish, longitudinal, sublateral stripes; they are uninterrupted and nearly equal. Sides of tergites, which are curved towards sternites, are greyish, similar to the whole ventral side. Genitalia short, moderately well developed; the 9th sternite is conical, rounded at apex; space between lower forceps and 9th sternite rather large.

Female

Very similar to male, but vertex is broader, occupying at least 1/3 of head width; abdomen a little broader, regularly conical.

Length of body 19 mm, of wing 13 mm.

NEW SOUTH WALES: 1 ♂, 20.xii.1929, 1 ♀, 15.xii.1929, Yass (K. English); 1 ♀, Dec. 1936, Canberra (M. Fuller); 1 ♀, 21.i.1948, 1 ♀, 9.i.1948, 1 ♀, 30.xii.1947, Canberra (S. J. Paramonov); 1 ♀, Jan. 1926, Kuringai Chase (Nicholson); 1 ♀, Roseville, near Sydney. QUEENSLAND: 2 ♀♀, 20.xi.1927, Stanthorpe (E. Sutton).

Types in the Division of Entomology Museum, C.S.I.R.O., Canberra.

26a. Apiocera hardyi angustifrons, subsp. nov. ♂, ♀

Very similar to *A. hardyi hardyi*, but differs mainly in that the vertex is narrower in both sexes. It is very probable that the distribution of these forms is different; the typical subspecies occurs in the southern part of New South Wales and in inland Queensland. *A. hardyi angustifrons* in the coastal area of Queensland.

Male

Vertex not more than 1/5 width of head; space between eye and posterior ocellus as broad as the latter; the groove here is very deep.

Female

Vertex a little less than 1/3 width of head; groove between ocellar triangle and eyes very deep.

QUEENSLAND: 2 ♂♂, 14.xii.1915 (type, Queensland Museum), 1 ♂, 20.xii.1917, 1 ♀, 4.xii.1911, Brisbane (H. Hacker); 1 ♂, Rockhampton (Brown); 1 ♂, 14.xii.1915, Brisbane (H. Hacker) (Agric. Dept.); 1 ♀, 28.x.1924, Westwood (Goldfinch); 1 ♀, Rockhampton; 3 ♀♀, 18.xi.1928, Emerald (F. Roberts). NEW SOUTH WALES: 1 ♂, 8.i.1917, Sydney.

Types in Queensland Museum.

27. APIOCERA NICHOLSONI, sp. nov. ♂, ♀

Very similar to *A. hardyi*, sp. nov., but differs from it in the width of vertex in both sexes, and by the markings on the abdomen.

Male

Vertex about ¼ of head width; ocellar triangle a little more than ½ width of vertex; distance between eye and posterior ocellus nearly 3 times the width of the latter (viewed from above); ocellar triangle broader than in *A. hardyi*. Facets nearly equal, small (in *A. hardyi* they are a little larger, particularly in border area of frons). Bristles on occiput yellowish, but as a rule with several black ones.

Middle brown stripe on 2nd, 3rd, and 4th tergites is 1.5 times the breadth of the greyish submedian stripes (in *A. hardyi* they are about equal in length). At sides of 2nd, 3rd, and 4th tergites near junction with sternites there are very distinct brown elongated spots (they are absent in *A. hardyi*). Other characters as in *A. hardyi*.

Female

Similar to the male, but vertex and abdomen broader. Face at antennal level is distinctly broader than horizontal diameter of eye viewed from front (in *A. hardyi* nearly equal). Middle brown stripe on 2nd, 3rd, and 4th tergites twice as broad as greyish submedian ones (in *A. hardyi* only a little broader). These greyish stripes are distinctly excavated on outer and inner sides (in *A. hardyi* they are nearly parallel-sided). Sides of 2nd, 3rd, and 4th tergites as in male with brown spots.

Length of body 17 mm, of wing 12 mm.

NEW SOUTH WALES: 4 ♂♂, 2 ♀♀, 9.xii.1923, Heathcote, near Sydney (A. J. Nicholson), on *Kunzea* flowers; 1 ♂, 9.xii.1923, Hornsby, near Sydney.

Types in the Division of Entomology Museum, C.S.I.R.O., Canberra. The author named this species in honour of Dr. A. J. Nicholson, who has collected many new species of Diptera in eastern and particularly in Western Australia.

28. APIOCERA FULLERAE, sp. nov. ♀

Ground colour very dark, nearly black; only 3rd joint of antennae brownish, tibiae brown, a little translucent; halteres yellow.

Vertex distinctly broader than eye and more than 3 times broader than ocellar triangle. Deep grooves between ocellar triangle and eyes. Head with yellowish dusting, brownish on frons (except the sides); hairs brownish on frons, on remainder of head nearly whitish. Long bristles on upper side of 2 basal joints of antennae and several on occiput black. First antennal joint cylindrical, rather thick, 3 times longer than the rounded 2nd joint; 3rd joint as long as 1st, pear-shaped, with short appendix at apex. Proboscis short, extending a little beyond apex of antennae; labella large, 1/3 length of proboscis. Palpi reaching to apex of 2nd antennal joint; 2nd palpal joint rounded at apex, twice as broad as at base.

On middle of mesonotum a broad dark brown, longitudinal, parallel-sided stripe, which extends from anterior border to the scutellum (and over it); it is as broad as an eye. There is only a trace of the central yellowish stripe, present in other species of this group. Outside the median brown stripe and about ½ as wide are 2 nearly parallel-sided whitish or greyish stripes, extending also over lateral edges of the scutellum, there are 2 sublateral broad, dark brown stripes, which are not parallel-sided; at the broadest point they are as broad as the middle brown stripe.

Sides of mesonotum with 2 lateral whitish stripes. Bristles well developed, black; 6 or 7 strong bristles on hind margin of scutellum. Sides of thorax densely whitish and greyish dusted, with long, dense, but very thin whitish hairs. Legs dark. Wings, venation as in *A. asilica*.

Abdomen dorsally with 3 dark brown, longitudinal, parallel-sided stripes (the middle one is twice as broad as the others) and 2 whitish greyish sublateral stripes. All stripes very well marked. Sternites uniformly dusted with white, and whitish haired. Lateral parts of tergites, which are curved down, are also whitish dusted, with brown spots on 2nd and 3rd tergites. Three last segments with erect hairs.

Length of body 18.5 mm, of wing 13 mm.

1 ♀, Pinjarra, W.A. (E. Goerling). Type in the Division of Entomology Museum, C.S.I.R.O., Canberra. The author named this species in honour of the late Miss Mary Fuller, the author of valuable papers on biology of different Diptera, who collected many interesting insects in Western Australia.

VIII. *Apiocera striativentris* group

This small group includes only 2 species: *A. striativentris*, sp. nov., and *A. lugubris*, sp. nov. Both species are typical of the *A. asilica* group, but the sharply marked stripes on the sternites in *A. striativentris* and a longitudinal lateral stripe on the tergites in *A. lugubris* are sufficiently distinctive to separate them from the *A. asilica* group.

29. Apiocera striativentris, sp. nov. ♂, ♀

Male

Vertex narrow, as broad as ocellar triangle and even a little narrower behind the posterior ocelli, occupying at least 1/9 of the head width. Ocellar triangle sunken, lower than tops of eyes, separated from eyes by extremely narrow grooves; it is situated well away from the hind border of eyes, about as far from them as ½ the distance between anterior and posterior ocelli; it is very long, almost as long as the distance from base of antennae to anterior ocellus. No deep grooves behind ocellar tubercle. Distance between posterior ocelli is at least ½ that between anterior and posterior ocelli.

Head with a whitish tomentum, but there is a very narrow brown median stripe on frons. Hairs on frons and ocellar tubercle brownish. Antennae brown, short, nearly as long as head. Third antennal joint pear-shaped, as long as 2 basal joints combined; bristles on basal joints yellowish, sometimes with several black ones. Proboscis extending only for ½ length of labella beyond apex of antennae, dark brown; labella broad, long, a little shorter than remainder of proboscis. Palpi reaching only to apex of 2nd antennal joint, and white-haired like the whole face. Second palpal joint twice as broad at apex as at base, regularly rounded at apex, and slightly curved. Hairs and bristles on occiput numerous, slightly yellowish.

Mesonotum with relatively indistinct stripes, which are clearer on anterior ½. There are 2 lateral, 2 submedian, and a median, yellow stripes alternating with 4 brown stripes: 2 sublaterals, very broad, irregular, and divided into 3 parts, and 2 regular, but narrower adjacent to central yellowish (there is in fact 1 brown median stripe divided by a yellow central one). Bristles on mesonotum mostly yellow. Four dark bristles on scutellum. Hairs on mesonotum dark. Sides of thorax whitish, white-haired, with irregular brownish spots, at least always on the mesopleura. Wings hyaline, venation normal, alula very well developed; ambient vein absent only along the border of axillary cell. Halteres brownish. Legs brown, with black bristles and mostly brownish hairs.

Abdomen narrow, narrower than thorax, elongated, and tapering apically, dark brown with white spots on dorsal side. Hairs on 1st and 2nd tergites are normal in length, not so distinctly longer than on the other tergites as in *A. asilica*. First, 2nd, and 3rd tergites with 2 small, sublateral, sharply marked, whitish, triangular spots at hind margin; 3rd tergite has also 2 similar spots at side in front corner; 4th and 5th tergites mostly whitish, with dark, median, longitudinal stripe; 6th and 7th tergites dark. The 1st 4 tergites have large, brown, isolated spots laterally near junction with sternites.

Sternites white, but 1st, 2nd, and 3rd with 3 brown, very narrow, but distinct, longitudinal stripes; these stripes begin on the anterior margin, but do not reach the posterior. Genitalia equal in length to 2 last segments. Ninth sternite is nearly ½ as long as lower forceps, twice as long as broad, conical, rounded on tip.

Female

Vertex occupying nearly 1/3 of head width. Pattern on abdomen similar to that of male, but apical part with dark colour more developed. Only last segment with numerous, short, erect, dark hairs. Body broader than in male; abdomen at base as broad as the thorax.

Length of body 18 mm, of wing 11.5 mm.

NEW SOUTH WALES: 1 ♂, 31.i.1937, Countegany (M. Fuller); 1 ♂, 1.i.1936, Queanbeyan, near Jerangle (Mackerras); 1 ♂ (sine data); 11 ♂♂, 4 ♀♀, 17-22.i.1936, Tuross (K. C. McKeown). Types in the Division of Entomology Museum, C.S.I.R.O., Canberra, cotypes also in Australian Museum, Sydney.

30. APIOCERA LUGUBRIS, sp. nov. ♂

Very closely related to *A. striativentris*. Vertex narrow, approximately 1/7 of head width. Ocellar triangle long, elongated, not higher than the eyes, placed rather far from the occipital line, nearly as broad as vertex, dark brown, with dark brown hairs. Middle of frons with dark brown longitudinal stripe, the sides yellowish, hairs brown. Antennae nearly as long as head, of typical form, but the 3rd antennal joint is pear-shaped with much longer basal part, a little longer than 2 basal joints together; basal joints with long, numerous, strong dark bristles. Proboscis in all 3 specimens examined in different position: in one it reaches only ½ way along 3rd antennal joint, in another whole labella is protruding beyond apex of antennae, in the 3rd it has an intermediate position. Labella large, a little longer than 3rd joint. Palpi reaching base of 3rd antennal joint; apical joint is very curved on upper side, on the under side nearly straight, therefore at apex below it is nearly acute; hairs long, yellowish, but some black bristle-like hairs may also be present. Occiput very dark, chiefly with yellowish hairs and bristles, but in the upper part there are always some black bristles.

Ground colour of mesonotum and hairs dark brown, nearly black, therefore the 4 whitish longitudinal stripes are clearly contrasted with ground colour. Median dark stripe is at least 3 times broader than the submedian whitish ones; it is parallel-sided in anterior ½, then widening in a curve, and narrowing at end of whitish stripes. Whitish stripes narrow, for 2/3 of length nearly parallel and then diverging a little before cutting out; the continuation of these stripes is represented by 2 oval, small, but very evident whitish spots before the scutellum. Lateral whitish spots relatively narrow and divided into 4 parts: 1 isolated spot on humeral callus, 2nd in notopleural depression, 3rd on postsutural tubercle, 4th on outer side of postalar callus. Scutellum dark brown, with very dense and long hairs of same colour and whitish ones on hind margin; as a rule 6 bristles present. Notopleural bristles numerous, with dense brown hairs between them. In centre of mesopleurae, in upper part of sternopleurae, around the hind spiracle, and above the hind coxae there are large brown spots, remainder is whitish dusted with whitish hairs. Halteres yellow. Wings hyaline, veins at anterior border and at base yellowish. Venation normal. Legs reddish, with black bristles.

Abdomen at base nearly as broad as thorax, not very narrow. Dorsal side dark brown with small, very contrasting whitish spots. Two small whitish spots on hind margin of 1st tergite, not touching the sides; 2 similar spots on 2nd, 3rd, and 4th tergites, but situated nearer to the middle line (submedian spots), a similar pair of spots on 5th tergite and another pair on the anterior margin. The remaining tergites have small spots of irregular shape.

The lateral, curved part of tergites is whitish as are all sternites, but at boundary of tergites and sternites on 2nd, 3rd, and 4th tergites there is a broad, nearly parallel-sided, brown, longitudinal stripe. Hairs on dorsal side black or brownish, except that on the 1st and 2nd tergites there are long, dense, whitish hairs, similar to those of typical *A. asilica* group. Ventral side with long whitish hairs.

Length of body 23 mm, of wing 13 mm.

QUEENSLAND: 1 ♂, 3.xii.1912, Stradbroke I., near Brisbane (H. Hacker), type in Queensland Museum. NEW SOUTH WALES: 1 ♂ (Macleay Museum); 1 ♂, 31.xii.1925, Kurnell (School of Public Health and Tropical Medicine, Sydney).

IX. *Apiocera latifrons* group

This group comprises 5 closely related species, all of which are new: *A. latifrons, A. contrasta, A. tropica, A. angusta, A. unicolor.*

It is closely related to the *A. minor* group, but the alula is larger than the triangular cell at the base of the wing. In 4 of the 5 species the alula is much larger than the cell, but in *A. latifrons*, sp. nov., it is only slightly larger. To reduce the possibility of incorrect identification this species is included in both alternatives in the key. As both sexes are known in only 1 of the species, and it is also likely that further collection will result in the discovery of more species, this classification is tentative only, and more precise distribution of the species into groups must await further study.

31. APIOCERA LATIFRONS, sp. nov. ♂, ♀

Male

Vertex a little broader than 1/3 of head width, a little less than 3 times as broad as ocellar triangle; grooves between the eyes and ocellar triangle very deep. Ocellar triangle nearly equilateral, comparatively short. Frons and face nearly parallel-sided, whitish yellow dusted; hairs on frons brownish, on face whitish. Antennae rather long; 3rd joint long and broad, longer than 2 basal joints together, ellipsoidal, similar to that of *A. similis*, sp. nov., in profile nearly twice as long as, and twice as broad as the 1st joint; bristles long, black, and brown. Proboscis very long, 2-3 times as long as head. Labella distinct, but only a little broader than the remainder of proboscis, occupying 1/3-1/4 of proboscis length; palpi protruding beyond the apex of 2nd antennal joint, yellowish, with whitish and brownish hairs, slightly curved; apical joint only a little broader at apex than at base. Occiput with very numerous black bristles.

Mesonotum (rubbed) with usual yellowish and brown longitudinal stripes; it is clear, however, that the stripes are not very well developed and not very contrasting. Bristles very long and strong. Hairs between the notopleural bristles whitish. Under side of thorax white dusted and haired. Legs yellow-reddish, bristles black. Halteres yellow-brownish. Wings hyaline. Ambient vein absent. Subdiscal cell isolated, vein m_{3+4} represented by very short veinlet, and connected with lower basal cell by similar short veinlet. Vein m_2 short, weak, about 1/3 as long as m_1. Vein *r-m* on the middle of discal cell. Alula small, distinctly larger than the triangular cell at base, but ½ as wide as the axillary cell.

Abdomen elongated, narrow, similar to that of *A. brevicornis* etc. Pattern of abdomen also similar, but on anterior border of the 4th tergite there are in addition 2 whitish triangular spots. Brown colour on hind ½ of 2nd, 3rd, and 4th tergites reaches pleural membrane in the form of broad stripe.

Female

Very similar to male. Vertex nearly of same width. Abdomen a little broader. Only last (7th) segment with dense, erect, dark hairs. Pattern similar to that of *A. brevicornis*. Vein m_2 a little longer than in male. Subdiscal cell touching the lower basal cell.

Length of body 13.5 mm, of wing 7.5 mm.

1 ♂ (type) and 3 other badly preserved males, 2 ♀♀, all with labels: "S. Australia"; in Macleay Museum.

The following material was collected by the author:

NEW SOUTH WALES: 2 ♂♂, 2 ♀♀, 24-27.x.1949, near Bourke; 2 ♂♂, 1 ♀, 28.x.1949, Warrego R., Wanaaring; 2 ♀♀, 19.xi.1949, Fowler's Gap; 1 ♀, 4.xi.1949, Naryllco-Orientos (this specimen has a yellowish tinge on wings); 1 ♂, 31.x.1949, Salisbury Downs-Clifton Downs.

Length of body 12-16 mm, of wing 8-11 mm. The females are distinctly larger and broader.

32. APIOCERA CONTRASTA, sp. nov. ♂

A representative of a small group of species around *A. tropica*, superficially very similar to *A. brevicornis*, but the white markings on the abdomen are much more developed, making it predominantly whitish rather than brownish (in *A. brevicornis* contrarily).

Vertex broad, occupying approximately ¼ of head width. Ocellar triangle broad, distance between eye and posterior ocellus being equal to width of posterior ocellus. Antennae a little longer than usual, because the 3rd antennal joint is elongated, distinctly longer than 2 basal joints together; it is not pear-like as usual, but elongate ellipsoid, cigar-like, similar to that of *A. similis*, sp. nov. Proboscis rather long, protruding a little beyond the apex of antennae. Labella large, nearly 1/3 of the length of proboscis. Palpi protruding to apex of 1st antennal joint; apical joint broadly widened in apical part, of usual form. Bristles on antennae yellow. All hairs on head yellowish; some of the strongest bristles on occiput dark.

Mesonotum (rubbed) with a very narrow central whitish stripe, which runs only ½ way along the mesonotum, but contrasting with a brownish stripe on each side. These brown stripes are confluent well in front of scutellum and where they join the scutellar suture (partly on the scutellum itself) there is a large white spot. There are 2 submedian whitish stripes and 2 brown sublateral stripes which are too rubbed in the specimen examined to permit exact description of their form; the whitish lateral stripes are very broad and well developed. Sides of scutellum distinctly whitish. Scutellum with 5 dark bristles. Hairs between the notopleural bristles whitish. Sides of thorax uniformly white dusted and white haired. Halteres yellow. Wings hyaline, with yellowish veins. Ambient vein quite absent. Subdiscal cell isolated: vein m_{3+4} lacking and the subdiscal cell connected with lower basal cell by a short veinlet; although this cell is much shorter than the discal cell, it is not much shorter than usual. Vein m_2 very weak, ½ as long as m_1. Vein *r-m* placed distinctly beyond the middle of discal cell. Common stem of r_4 and r_5 as long as distal part of upper side of discal cell. Alula very large. Legs reddish, with long black bristles.

Abdomen narrow, elongated, as in *A. brevicornis, A. similis,* etc. White colour on the upper side is very well developed, contrasting strongly with dark markings; pattern very sharply marked. First tergite quite whitish; 2nd tergite with 2 whitish, very high triangles, which occupy the greater part of tergite; the middle dark brown stripe does not reach the hind margin, the lateral stripes are still shorter, but the basal 1/3 is entirely dark brown. Third tergite with 2 much smaller and lower whitish triangles at hind margin, which are developed in the transverse direction; at anterior margin there are also 2 whitish triangles in the lateral corners; 4th tergite white with brown cross markings: 1 longitudinal narrow stripe and another broader cross band; on the 5th and 6th tergites the white colour is even more developed; the 7th tergite and genitalia are brown.

At the joining line with sternites on the 2nd, 3rd, and 4th tergites there are large, brown, rounded spots, connected with the brown colour of the upper side of abdomen. Sternites whitish, white haired.

Length of body 17 mm, of wing 9 mm.

1 ♂, South Australia; type in Macleay Museum, Sydney.

33. APIOCERA TROPICA, sp. nov. ♀

The species of this group are small (length of body at most 13.5 mm), sparsely haired, with elongated conical abdomen, characteristic venation, and pattern on mesonotum and abdomen not sharply marked.

Ground colour of body not black, but dark brown, dull. Body narrow, abdomen elongated, conical, without a contraction of the apical segments as in *A. asilica* group. Vertex distinctly broader than eye, 3 times broader than ocellar triangle. Proboscis short, protruding for the length of head, labella in profile only a little broader than proboscis itself; the length of the labella nearly equal to that of apical joint of palpi. Palpi whitish, protruding only to the apex of 1st antennal joint, with soft white hairs; distal ½ of apical joint broad, rounded at apex, and twice as broad as at base. Antennae short, nearly as long as head. First 2 joints yellow, 3rd black. First and 3rd joint nearly equal, 2nd round, slightly more than 1/3 as long as 1st joint. Third joint pear-like, with very distinct small style. Black bristles on upper side of 1st 2 joints comparatively few and shorter than 1st antennal joint. Bristles on occiput mostly black. Head densely dusted, on upper ½ yellowish grey, on lower ½ whitish.

Mesonotum (rubbed) with traces of 2 narrow, submedian, parallel, brown, longitudinal stripes. Bristles on mesonotum numerous, black. It is clear that mesonotum even in the perfect condition is sparsely haired. Scutellum short, projecting only a little over the anterior border of the 1st tergite, nearly bare, but with 4 long black bristles. Sides of thorax nearly bare. Bristles on coxae whitish. Legs yellow, with numerous dark brown bristles. Halteres yellow. Wings hyaline, veins in basal ½ yellowish. On the anterior margin at the base of the costa there are extremely short black hairs. Alula rather well developed, its width is more than ½ that of axillary cell and nearly equal to the width of the discal cell. Costa reaching almost exactly to the apex of wing; veins m_1, m_2, m_4 pale, weak; vein m_1 regularly curved and ending just at apex of wing; vein m_2 not very short, ½ as long as and parallel to vein m_1. Subdiscal cell long, only a little shorter than discal cell, touching the cell M (lower basal).

Abdomen dark brown, without sharply marked pattern. On median line there are large darker, but very indistinct spots. On sides of 1st tergite there are some black bristles. Hairs on abdomen microscopic. Seventh segment with black, erect, dense hairs. Upper side greyish dusted.

Length of body 13.5 mm, of wing 9 mm.

1 ♀, 30.xii.1911, Borroloola, N.T. (G. F. Hill). Type in National Museum, Melbourne.

34. Apiocera angusta, sp. nov. ♂

Closely related to *A. tropica*, *contrasta*, etc. Vertex narrow, occupying approximately 1/7 of head width. Distance between eye and posterior ocellus equal to width of ocellus. Proboscis protruding a little beyond the apex of antennae; labella large, 1/3-1/2 of proboscis length. Palpi narrow, reaching the apex of 1st antennal joint, apical joint only slightly curved and not very dilated; palpi with not long, yellowish hairs, which are not numerous. Antennae short, typical for this group, 3rd joint somewhat pear-shaped, a little longer than the 1st joint; both basal joints yellow, 3rd joint brown; bristles of antennae yellowish and brownish. Head whitish dusted, without brown markings on frons or ocellar triangle, hairs yellowish, only several bristles on occiput darker, brown.

Mesonotum (none of the specimens is very well preserved) with whitish and brownish longitudinal stripes. Lateral whitish stripes very broad. Hairs between the notopleural bristles whitish. Under side of thorax whitish, white haired. Legs, halteres, and most of venation yellow. Venation normal, but ambient vein absent, and the subdiscal cell is connected with lower basal cell by a short veinlet; veins m_2 and m_{3+4} weaker than usual.

Ground colour of abdomen brown; genitalia and 2 last segments yellow; yellowish white markings well represented. First tergite whitish except for brown spots at the sides; 2nd brown, with 2 whitish, submedian triangles at hind margin, reaching to only ½ the width of the segment; 3rd and 4th tergites with similar pattern, but the triangles are lower and all 3 tergites without brown markings at sides at boundary with sternites. Remaining tergites mostly brown. Sternites whitish. Hairs on abdomen comparatively scarce. Genitalia comparatively short. Lower genital plate (9th sternite) small, the free space around it very large.

Length of body 12 mm, of wing 8 mm.

3 ♂♂, Mataranka, N.T. Type in School of Public Health and Tropical Medicine, Sydney.

35. APIOCERA UNICOLOR, sp. nov. ♂

Very similar to *A. latifrons*, but differs in the reddish ground colour of the whole body, and the nearly complete absence of markings.

Proboscis long, nearly 3 times as long as head; labella broader than proboscis, but short, approximately 1/5 of the length of proboscis. Palpi long, approximately ½ the length of proboscis, apical joint only a little broader at apex than at base; brownish hairs on upper side, whitish on under side. Vertex a little less than 1/3 of head width. Ocellar triangle short, separated from eyes by 2 deep grooves. Third antennal joint is elliptical, long, nearly as long as 2 basal joints together. Bristles on head, as on entire body, brownish.

Mesonotum and scutellum reddish, without markings. Under side of thorax long and dense whitish haired. Wings hyaline, veins yellow, many of them weak, particularly on distal part. Ambient vein present. Subdiscal cell isolated, without appendix. Vein *r-m* a little before the middle of discal cell. Alula small, but distinctly larger than the triangular cell at base of wing, ½ as broad as and very much shorter than the axillary cell.

Abdomen with traces of more whitish markings on the anterior part of tergites.

Length of body 12 mm, of wing 7.5 mm.

1 ♂, 20.xi.1886, 8 miles NW. of Queenscliff, Vic. (Tepper). Type in South Australian Museum.

X. *Apiocera ferruginea* group

This group contains only 2 species: *A. ferruginea*, sp. nov., and *A. vulpes* Herm., of which but little material is available for study.

The reddish ground colour of body is the essential character of this group.

36. APIOCERA FERRUGINEA, sp. nov.

Vertex narrow, approximately occupying 1/7 of head width. Ocellar triangle very long; distance between eye margin and posterior ocellus equal to breadth of ocellus. Proboscis twice as long as the head, labella broad and long. Palpi protruding at least to the apex of 2nd antennal joint; under side of apical joint slightly curved, nearly straight, at apex tapering a little. Antennae very short, 3rd joint elongated pear-like, nearly as long as 2 basal joints together. All bristles on head as on entire body brownish red, hairs on frons reddish, the remainder whitish.

Mesonotum and scutellum without stripes or spots, uniformly reddish, hairs yellow. Under side of thorax with dense, long, whitish hairs. Halteres and legs yellow-reddish. Veins of wing yellow. Alula large, nearly as broad as axillary cell. Venation normal. Vein *r-m* a little beyond the middle of discal cell.

Abdomen of *A. asilica* form: broad at base and very narrow in apical part. Hairs on abdomen reddish and whitish, rather dense, but short. No stripes, fascia, or spots on abdomen.

Length of body 22 mm, of wing 13 mm.

1 ♂, 4.v.1884, Largs Bay, near Adelaide, S.A. (Tepper); 1 ♂, Ankertell, W.A. (H. W. Brown). Type in South Australian Museum.

37. Apiocera vulpes Hermann ♀

Hermann, 1909, Dtsch. ent. Z. **1909** (2): 108.

The author has not seen this species, but has received additional information about the type in Munich. Herman describes this species as follows:

"1 ♀, aus meiner Sammlung, 1 ♀ aus der Sammlung des K. ungarischen Nationalmuseums, beide Exemplare aus Queensland. Die Species zeichnet sich gegenüber den übrigen Arten durch die mehr oder minder lebhafte ziegelrote Grundfarbe des ganzen Körpers deutlich aus.

Kopf. Die ziegelrote Grundfarbe wird im Gesicht und auf der Stirne von bleichgelber Bestäubung bedeckt, tritt aber auf dem Scheitel und in der Umgebung der Ocellen frei zu Tage und erstreckt sich ausserdem als zungenförmiges Feld noch eine Strecke weit gegen die Fühlerwurzel hinab. Die feine, wesentlich den inneren Orbitalrand einnehmende Behaarung ist schwarz, das Untergesicht jedoch ist weiss behaart. Fühler rotgelb mit teilweise lichterer Bestäubung. Der groben, schwarzen, borstenförmigen Behaarung der beiden Basalglieder sind auch einige gelbe Borsten beigemengt. Taster licht ziegelrot mit gelblicher Bestäubung und dichter weisslicher Behaarung. Rüssel braun. Das hellgrau bestäubte Hinterhaupt trägt oben einen schwarzen Borstenkranz, ausserdem aber weichere gelbliche Behaarung, die nach abwärts in den wenig ausgebildeten Backenbart übergeht.

Thorax ziegelrot; eine durch eine schwarze Medianlinie gebildete Mittelstrieme geht vor dem Schildchen allmählich in die fleckenartigen Seitenstriemen über. Bei näheren Zusehen erkennt man, dass die dunklere Färbung dieser Stiemenzeichnung eine fleckenartige Marmorierung entsteht, die lebhaft an die Felderung braunlakierten Krokodilleders erinnert. Schulterbeulen, seitlicher Thoraxrand und die Interstitien zwischen den Thoraxstriemen durch Bestäubung licht. Die ziegelroten Pleuren erscheinen durch weissliche Bestäubung und gleichfarbige, ziemlich dichte Behaarung hell. Irgendwelche auffallende Behaarung vor den rötlichen Schwingern fehlt, dagegen findet sich vor der Flügelwurzel ein Büschel längerer weisslicher Haare, denen aber auch einige von schwarzer Farbe beigemengt sind. Auf dem Thoraxrücken ist die wenig in die Augen fallende kurze Behaarung rein schwarz, ebenso die groben Borsten, die von der Flügelwurzel bis zu den Postalarhöckern den Thoraxrücken einfassen. Einige schwarze Borsten finden sich auch am Rande des ziegelroten, vorwiegend weisslich behaarten Schildchens.

Abdomen ebenfalls ziegelrot, jedoch ist im Bereiche der ersten 3-4 Segmente in der Mitte die Farbe, namentlich gegen die Basis der Segmente, entschieden düsterer. Bei tadellos konservierten Stücken mag vielleicht dadurch eine Art von dunklerer Mittellinie auf dem Abdomen gebildet werden. Von lichteren

Zeichnungen ist an den beiden mir zu Gebote stehenden Exemplaren nicht mehr zu sehen, immerhin zeigen Reste derselben, dass die Zeichnung auf die nämlichen seitlichen, dreieckigen Bestäubungsflecke zurückzuführen sein dürfte, wie sie bei allen bis jetzt bekannt gewordenen *Apiocera*-Arten die mittleren Abdominalsegmente an ihren Hinterrändern zieren. Die wenig auffallende kurze Behaarung des Abdomens ist schwarz, nur auf dem ersten Segmente wird sie seitlich reichlicher und besitzt hier auch lichtere Färbung.

Beine. Hüften ziegelrot mit weisslicher Behaarung und ockergelben Borsten. Beine ebenfalls ziegelrot mit mässigem Glanze. Die anliegende, zerstreute Behaarung ist ebenso wie die gröberen Borsten schwarz. Auf der Innenfläche der Verderschiene läuft ein Streifen sehr zarter und dichter Bestäubung von fast goldgelber Färbung herab.

Flügel schwach gelblich, sehr durchscheinend, Aederung an der Basis und dem Vorderrande ziegelrot, im übrigen düster rotbraun. Randader schwarz beborstet.

Long. corp. 22 mm. Long. alar. 14 mm."

At my request Dr. W. Forster (Munich) has kindly given me the following details about the type:

"1. Dichte abstehende Behaarung befindet sich nur auf dem letzten Segment.
2. Von oben gesehen ist der Scheitel gleich, eher schmäler als der Augendurchmesser.
3. Die Costalader reicht am Hinterrand des Flügels bis zur Analzelle.
4. Das Geäder gleicht völlig der Abb. 2, bei Hermann (Dtsch. ent. Z. 1909: 105).
5. Die Alula ist wesentlich schmäler als die Axillarzelle.
6. Das 3. Fühlerglied ist birnförmig, das 2. Tasterglied verbreitert.
7. Am Hinterrand des Schildchens trägt das Tier nur eine Borste, die übrigen sind abgebrochen. Nach der Insertionsstellen waren vier.
8. Die Grundfarbe des Tieres ist rotbraun, es mag sein, dass es im frischen Zustande mehr rot war.
9. Das Tier ist glänzend, wie lakiert.
10. Der Rüssel ist deutlich länger als der Kopf."

XI. *Apiocera brevicornis* group

This group consists of the following 13 species: *A. brevicornis* Wied., *A. similis*, sp. nov., *A. acutipalpis*, sp. nov., *A. victoriae*, sp. nov., *A. moderata*, sp. nov., *A. aliena*, sp. nov., *A. reginae*, sp. nov., *A. picoides*, sp. nov., *A. longitudinalis*, sp. nov., *A. albanyana*, sp. nov., *A. englishae*, sp. nov., *A. asiloides*, sp. nov., and *A. bigoti* Macq.

The last species could belong alternatively to the *A. asilica* group. No data are available about this species other than Macquart's description.

The group can be regarded as a subgroup to the *A. asilica* group as there are no characters readily separating it. In general all species are much smaller, not so robust as in *A. asilica*, and the abdomen does not narrow so markedly in the apical ½.

More detailed study will perhaps show further differences between the 2 groups.

38. Apiocera brevicornis Wiedemann

Wiedemann, 1830, Aussereuropäische Zweiflügel Insekten **2**: 646.

Macquart, 1838, Dipt. exot. 1 (2): 79. Tab. VI, fig. 5 (Tapinocera).

Wiedemann described this species as follows: "Nigra, albo-picta; alis limpidissimis.

Schwarz, weiss gezeichnet, mit sehr wasserklaren Flügeln. ♂. Von Neuholland. Taf. X. (No figure on plate X.—S.P.)

Fühler sehr kurz, dicht über dem Munde eingefügt, schwarz, Wurzel mit schwarzen Borsten. Bart weiss; Stirn hoch, etwas convex, senkrecht liegend, gelblich behaart. Rückenschild sehr abgerieben; doch sind drei weissliche Striemen deutlich; Brustseiten zum Theil weiss. Hinterleib sehr abgerieben, zum Theil schwarz behaart. Afterzange länglich, schwarz. Flügeladern braun. Beine bräunlich-schwarz; Schienen mehr weniger gelblich. Übrigens von schlanker Statur und darin mehr einem *Asilus* ähnlich. Im Berliner Museum."

Professor F. Peus has kindly informed the author that the type in Berlin Museum is now absent.

The female of *A. brevicornis* differs from that of *A. similis* in the shape of 3rd antennal joint, also by the very narrow light median stripe of mesonotum, which is 3-5 times narrower than the brown submedian stripes, whereas in *A. similis* it is nearly equal to them in width. The broad brown longitudinal sublateral stripes are complete, i.e. not separated intc 3 parts by light cross bands; in *A. similis* these cross bands, especially that at the suture, are very distinct. These characters serve also to differentiate the males of both species.

The author has seen the males and females from the following localities:

NEW SOUTH WALES: National Park (Gundamain), 14.ii.1926 (I. M. Mackerras); Alpine Creek, Kiandra, 8.i.1928 (I. M. Mackerras); 26.i.1935 (T. G. Campbell); Blackheath, 1.ii.1926 (A. J. Nicholson and I. M. Mackerras); Loddon Falls, 23.i.1926 (Mackerras); 1 ♂, 30.i.1926, Gundamain, Port Hacking (A. Musgrave). QUEENSLAND: Eidsvold (Bancroft).

39. Apiocera similis, sp. nov. ♂, ♀

Very similar to *A. brevicornis*, but smaller; 3rd joint of antennae much longer, at least 3 times longer than the 1st joint, black, cigar-like.

The white and brown stripes of the mesonotum are not so well developed as in *A. brevicornis*, and the broad brown sublateral stripes are divided by 2 cross white markings (as in *A. asilica*).

The white spots on the 1st tergite are big, being less wide than long (contrary to the condition in *A. brevicornis*). The white spots on the 2nd and 3rd tergites are also relatively long, and connecting one another at the hind border of the segment. The anterior border of the 4th segment has 2 very small white spots. Tergites 6-8 are brown.

Genitalia shorter than in *A. brevicornis*.

Length of body 15 mm, of wing 8 mm.

Female

Very similar to the male, but the 3rd antennal joint is proportionally a little shorter, cigar-like.

AUSTRALIAN CAPITAL TERRITORY: 1 ♂, 9.i.1936, Canberra, Black Mt. (W. Rafferty); ♂ ♂, ♀ ♀, 18.xii.-12.ii.1947, 1948, 1949, Canberra (S. J. Paramonov). QUEENSLAND: 1 ♂, 1 ♀, 18.xi.1928, Emerald (F. Roberts); 1 ♀, Sept. 1926, Dunwich (I. M. Mackerras).

Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

40. APIOCERA ACUTIPALPIS, sp. nov. ♂

Closely related to *A. brevicornis*, but differing from all other Australian species in the tapering apical joint of the palpi.

Body elongated, dark brown, with markings, which are rather developed, but not very contrasting with the ground colour.

Vertex very narrow, occupying approximately 1/9 of head width. Ocellar triangle nearly as broad as vertex, elongated; viewed from front, a little higher than the eyes; separated from the eyes by 2 extremely narrow and deep grooves; situated rather far from the occipital line; distance between the anterior ocellus and base of antennae about 1.5 times longer than ocellar triangle. Frons and face yellowish dusted, on the frons there is a very narrow median, brown stripe, which reaches only ½ way to the base of antennae. Hairs on frons brownish. Proboscis (in type broken) on the level of apex of antennae. Antennae typical, short, 3rd joint pear-like. Palpi almost reaching the apex of 2nd joint of antennae; apical joint as broad at apex as at the base, its under side nearly straight, the upper side slightly bowed; this joint tapers from its middle and is very narrow, but rounded at apex; there is a big, readily visible pit on this palpal joint. Palpi and occiput with long yellowish hairs. Occipital bristles black.

Mesonotum with poorly developed markings (the type is not very well preserved). A broad, brown, median stripe is clearly discernible, divided by a central, narrow, yellowish one; the submedian yellowish stripes are irregular and developed only anteriorly; 2 broad, irregular sublateral brown stripes are interrupted behind the humeral calli. Scutellum dark, with paler sides, its hind margin with long, nearly whitish hairs. Under side of thorax very densely yellowish haired.

Wings hyaline, venation normal, veins brownish, alula very long and broad. Vein *r-m* distinctly beyond the middle of discal cell. Halteres light brownish. Legs reddish brown.

Shape of abdomen very similar to that of *A. brevicornis*, but there are greyish markings on the 2nd, 3rd, and 4th tergites forming 2 pairs of triangles: one on the anterior, another on the posterior margins. No well-marked brown spots at sternites. Hairs on the 1st and 2nd tergites are long, but brown, not pure white as in *A. asilica* group (sens. str.), under side of abdomen brownish haired. No characteristic features in genitalia.

Length of body 18 mm, of wing 10 mm.

1 ♂ (no data), type in Macleay Museum, Sydney.

41. Apiocera victoriae, sp. nov. ♀

The abdomen is narrower than the thorax, elongated, conical, narrowing regularly; the markings of the abdomen are quite distinctive; the striping of the mesonotum is poorly developed, as are the hairs on the sides of the thorax.

The ground colour of the body is dark brown. The head is densely yellowish dusted. Vertex broad, about equal to 1/3 of the head width, about 3 times broader than ocellar triangle. Occiput with very numerous strong and long black bristles. The frons is covered with dark brown, comparatively short and scarce hairs. Proboscis short, extending a little beyond the apex of antennae. Labellum long, the proboscis (without labellum) at most twice as long as the labellum. Palpi yellowish, yellowish haired, extending at most to the apex of the 2nd antennal joint; the 2nd palpal joint is long, about as long as labellum, curving and gradually broadening towards the rounded apex. Antennae short, shorter than the head length; the antennal bristles very long, strong, black, numerous; the proportion and shape of the joints similar to those of *A. brevicornis.*

The thorax of this specimen is rubbed, but it seems likely that the markings of the mesonotum are poorly developed. Four black bristles on the scutellum. The hairs on the sides of the thorax are sparse. Wings as in *A. brevicornis,* halteres yellow. Legs yellowish brown, the black bristles on the anterior coxae are numerous and long.

The 1st tergite is mostly grey dusted, with a dark spot on each side and in the middle. The 2nd and 3rd tergites are brown with 2 pairs of similar whitish triangles; 1 pair on the anterior, the 2nd on the posterior margin, these pairs touch and form a Latin X or hour-glass; the 4th tergite has 1 similar pair of greyish spots only on the anterior ½. The following tergites are uniformly dark brown. The last segment of abdomen with dense, erect, black hairs. The hairs on abdomen are black, microscopic; the long white hairs on the sides of the 1st tergite, which are so characteristic for *A. asilica,* are lacking in this species.

The whitish triangles on the anterior ½ of the 2nd and succeeding tergites are found besides only in *A. moderata,* sp. nov.

Length of body 17 mm, of wing 11.5 mm.

1 ♀, 22.xii.1911, Ouyen, Mallee, Vic. (W. A. Hall). The type in National Museum, Melbourne.

42. Apiocera moderata, sp. nov. ♂, ♀

Easily distinguishable from other members of the *A. brevicornis* group by the presence of the white markings (mostly triangular) on anterior margin of the 1st to 4th tergites; only *A. victoriae,* sp. nov. has similar abdominal markings.

Vertex comparatively broad—in male it is a little narrower than an eye (by combined width of 2 ocelli); the space between the inner margin of the eye and posterior ocellus is equal to the space between the posterior ocelli.

In the female the vertex is markedly broader than the eye, and more than 3 times broader than the ocellar triangle. Proboscis moderately long, but projecting for the length of the labellum beyond the apex of the antennae. Antennae yellowish, 3rd joint dark, 1st 2 joints with rather numerous, very long and strong black bristles; 1st joint comparatively long, longer than the pear-like 3rd joint.

Palpi long, slender, reaching to the apex of the 2nd antennal joint; 2nd palpal joint is elongated, rounded at apex, twice as broad as the 1st palpal joint; in male the 2nd joint is covered mostly with black long hairs, in female these are few. The hairs on the frons are dense, long, dark brown. Bristles on occiput mostly black.

The markings on the mesonotum are as in *A. brevicornis*, but only moderately developed. Six black bristles on hind border of scutellum; all bristles of mesonotum are black. The hairs on mesonotum are not so dense and long as in typical species of the *A. asilica* group, particularly in region between the notopleural bristles. Wings as in *A. brevicornis*. Halteres yellow. Legs yellow.

Abdomen narrow, elongated, conical, narrower than the thorax. The markings are very similar to those of *A. asilica*, but on the anterior margin of the 1st to 4th tergites there are as a rule a pair of triangular white submedian spots. The dark brown markings are present on the sides of 2nd to 4th tergites at boundary with sternites. Genitalia of male moderately developed, as long as the 2 last tergites. In the female only the last segment is covered with erect, dense, black hairs. The hairs on abdomen very short.

Length of body 17 mm, of wing 11 mm.

1 ♂, 1 ♀, Swan R., W.A. (L. J. Newman). The types in the Department of Agriculture, Perth, W.A.

43. APIOCERA ALIENA, sp. nov. ♂

Closely related to *A. moderata*, sp. nov. Proboscis protruding only slightly beyond the apex of antennae (including the imaginable 3rd joint, which is missing in type), labella about 1/3 of whole length (in *A. moderata* proboscis protrudes very far beyond the apex of antennae, labella comparatively short: ¼ of the whole length). Frons is not so deeply sunken as in *A. moderata*, preocular stripes are not so well developed as in *A. moderata*, and not so sharply separated from the other surface of frons. Vertex occupying 1/3 of head width.

Mesonotum with 2 narrow parallel brown stripes, reaching the scutellum, 2 broad brown sublateral stripes separated into 3 spots. Scutellum whitish, disc brown.

First tergite whitish along the anterior and posterior borders (in *A. moderata* the anterior border is brown, and there are also 2 oblique whitish sublateral stripes). Second tergite with 2 whitish separated triangles, occupying whole hind margin. Third tergite similar to the 2nd but triangles reaching less than ½ of the length of the tergites. Fourth tergite brown, with whitish anterior and posterior borders (pattern irregular). Fifth tergite similar, the remainder brownish. The apices of lower forceps as acute as those of upper ones (in *A. moderata* the apices of lower forceps are rounded and distinctly broader than those of upper forceps).

Length of body 14.5 mm, of wing 9 mm.

1 ♂, 25.ii.1914, Uralla, N.S.W. Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

1 ♂ from Sydney has much more protruding proboscis.

44. Apiocera reginae, sp. nov. ♂, ♀

Very similar to *A. similis*, sp. nov.

Male

Frons and face pure white, no brown spot below the anterior ocellus or on the ocellar triangle. Hairs on upper ½ of frons brown, on lower white. Vertex distinctly narrower than 1/5 of width of head. In profile parafacialia and mouth cavity sides invisible; parafacialia white haired. Antennae brownish, with mixed black and yellowish bristles. Shape and proportion of antennal joints as in *A. brevicornis*. Proboscis protruding a little beyond the apex of antennae, labella large, about 1/3 of the proboscis length. Palpi yellowish, yellowish haired; last palpal joint slightly curved, at broadest point as broad as 1st joint of antennae. Occiput with numerous black bristles.

Mesonotum greyish, with 5 brownish markings, but they are not so contrasting as in *A. brevicornis*, or *A. similis*; the shape of the markings is as in *A. similis*. Chaetotaxy as in *A. brevicornis* and *A. similis*. Tuft of hairs lateral to the supra-alar bristles predominantly white, not brown as in *A. brevicornis* or *A. similis*. Upper part of mesopleurae under the row of notopleural bristles whitish, without a brownish longitudinal stripe. Scutellum whitish dusted laterally and at apex. All coxae with whitish bristles. Legs brownish yellow, more yellowish.

Abdomen narrow, narrower than thorax, gradually tapering towards the apex. Hind border of 1st tergite greyish, not brown in the middle as in *A. brevicornis* or *A. similis*. Two greyish triangles on the 2nd tergite occupying the whole width of the tergite, connected and reaching about ½ the length of tergite. Triangles on 3rd tergite much smaller. Greyish spots at anterior lateral corner of 3rd tergite small. Brownish spots on 2nd to 4th tergites in sternite area very pale, with whitish hairs. Fourth tergite brown, with greyish hind margin, the remainder of abdomen brown, with a trace of greyish spots.

Genitalia similar to those of *A. brevicornis*, but the opening between the lower forceps is smaller, triangular, not heart-shaped, therefore the 9th sternite occupies the whole opening between the lower forceps.

Length of body 13.5-17.5 mm, of wing 9 mm.

Female

Very similar to the male. Vertex occupying about 1/3 of head width. As in male the metanotum is whitish dusted, not brown as in *A. brevicornis*. Distance between eye and posterior ocellus is distinctly less than width of ocellar triangle.

QUEENSLAND: 4 ♂♂, 1 ♀, 3.xii.1927, Goondiwindi (F. H. Roberts); 3 ♀♀, Jan. 1929, Magnetic I. (T. W. Fielding); 1 ♀, 24.ii.1927, Stanthorpe.

Type (male) in Division of Entomology Museum, C.S.I.R.O., Canberra.

45. Apiocera picoides, sp. nov. ♀

Closely related to *A. pica* Norr., but much more slender, and having the white markings on the 2nd tergite much smaller.

Body slender, similar to that of *A. brevicornis, similis,* etc., but not of *A. asilica*; having nearly same length of body, this species has a thorax slightly more than ½ as broad as that of *A. pica.* The sides of vertex are yellow, not dark brown as in *A. pica.* The sides of scutellum with distinct yellow pollinosity (in *A. pica* the entire scutellum is black). Second tergite viewed from above is entirely dark brown, except that at its hind margin there are 2 discrete, low, whitish triangles which reach nearly to the middle of the segment (in *A. pica* the white markings occupy the apical ½ of the tergite, being broadly separated in the middle, and the sides of this tergite are white when viewed from above). The last 2 tergites (the 6th and 7th) are covered with dense, erect, but short, black hairs.

Length of body 19 mm, of wing 12.5 mm.

1 ♀, Dec. 1941, Currency Creek, S.A. (J. S. Womersley). Type in the South Australian Museum.

46. Apiocera longitudinalis, sp. nov. ♀

The type is well preserved, but the head is missing. However, the extremely distinctive pattern of the abdomen makes this species very easily recognizable.

Mesonotum with 1 broad median and 2 broad sublateral brown stripes, which contrast with 2 whitish submedian and 2 similar lateral stripes. Median brown stripe occupying nearly 1/3 of mesonotum width, not divided by a very narrow central whitish stripe, such as occurs in many *Apiocera* species. There is only a small whitish triangle at the beginning of this stripe. Lateral white stripe is broad, extending from anterior end of thorax over humeral calli to the sides of scutellum. The 2 whitish submedian stripes extend only 2/3 of the mesonotum length and taper towards the scutellum. All bristles are long, strong; 4 bristles on scutellum. Hairs between the notopleural bristles whitish. Scutellum brown, with white sides. Under side of thorax whitish, white haired. Halteres yellow. Legs yellow, femora densely white dusted. Bristles on all coxae black.

Abdomen regularly elongated, 7th segment with dense, erect, short dark hairs. Upper side brown, with very sharply defined whitish markings. Hind margin of 1st tergite white, with 2 sublateral prolongations towards the base, so that there are 2 isolated brown spots at sides of tergite. Second, 3rd, 4th, and 5th tergites with 2 narrow "bracket-like" whitish markings, extending from anterior to posterior margin, the convex side of "brackets" directed towards median line of abdomen. On 2nd tergite a median brown stripe occupies approximately 1/3 of tergite width, "brackets" are 1/3 of width of this stripe; on 3rd tergite the brown median stripe occupies only ¼ of tergite width (the lateral brown stripe is broader than the median), "brackets" 1/3 the width of the brown stripe; on the 4th tergite the brown median stripe occupies less than 1/5 of the tergite width; "brackets" are ½ as wide as the median stripe; on 5th tergite median stripe is very narrow, narrower than the "brackets"; 6th and 7th tergites brown.

Under side of abdomen white, white haired on 2 basal sternites, with black hairs on the remainder. A distinct brown spot at touching line of second tergite and sternite.

Length of whole body 16 mm, of wing 11 mm.

1 ♀, Cunderdin, W.A. Type in the Queensland Museum.

47. APIOCERA ALBANYANA, sp. nov. ♂, ♀

Smaller than *A. brevicornis*. Very closely related to *A. reginae*, sp. nov. Below anterior ocellus there is always a brown marking. Proboscis protruding beyond the apex of antennae, labella narrow, and short, about as broad as the remainder of proboscis, and nearly as long as 3rd antennal joint. Antennae have the same proportions and shape as in *A. brevicornis*, brownish. Vertex in male is nearly 1/5, in female a little more than 1/3 of head width. In the male the distance between the eye and posterior ocellus is greater than the width of ocellus.

The whitish longitudinal stripes are poorly developed in both sexes. Among the notopleural bristles there are brownish hairs; they form an indistinct longitudinal brownish stripe.

Abdomen in both sexes elongated, conical. The whitish triangles are not very well developed, and not so sharply contrasted with brown surrounding area as in *A. brevicornis*.

Length of body 13-14 mm, of wing 9 mm.

WESTERN AUSTRALIA: 2 ♂♂, 3 ♀♀, 8.i.1935, 1 ♀, 7.i.1935, Albany (K. R. Norris); 1 ♂, Jan. 1935, Albany (M. Solomon). Type in the Division of Entomology Museum, C.S.I.R.O., Canberra.

The egg-laying of a female of this species was described by Norris (1936, p. 52). "All the specimens were collected along a sandy roadway through country timbered with *Casuarina*, stunted eucalypts, and a variety of sclerophyllous shrubs" (Norris, personal communication).

48. APIOCERA ENGLISHAE, sp. nov. ♂

Closely related to *A. moderata*, sp. nov., etc. Differs from all other species in the pattern of the white markings of the abdomen.

Vertex equal to 1/6 of head width. Distance between eye and ocellar triangle is less than width of 1 ocellus. Palpi broken, but 1st palpal joint has a few black bristles. Antennae broken, 1st joint normal, with black bristles. Proboscis rather long.

Halteres yellow, wings as in *A. asilica*, but cells M_2 and M_4 nearly equal at hind margin of wing. Legs yellowish brown.

Thorax very rubbed, but seems that the markings of the thorax would be poorly developed even in well-preserved specimens. Postnotal tubercles and space under scutellum uniformly grey dusted.

The entire upper surface of the abdomen is brown; on 2nd to 7th tergites there are submedian pairs of bracket-like greyish spots; these brackets are in the reverse position, turned convex side inwards, and extend from the anterior to the posterior margin of each tergite. Distance between these "brackets" on 2nd tergite a little greater than the width of each "bracket," but on each successive tergite the "brackets" are less widely spread until on the 4th and 5th tergites they are separated only by a very narrow line.

Lateral parts of tergites (visible from beneath) and the sternites are whitish dusted, without black spots. Hypopygium small, as long as last 2 segments. Distance between the lower forceps (viewed from below) is long, triangular, the 9th sternite is short, triangular, distinctly shorter than ½ of the lower forceps; the space between distal halves of upper forceps very regularly oval. Hairs on under side of abdomen white; tergites with sparse, short, black hairs. On 1st tergite there are also few whitish hairs.

Length of body 16 mm, of wing 10.5 mm.

1 ♂, Salmon Gums, W.A. Type in W.A. Museum.

The author has named this species in honour of Miss K. English, author of an interesting article about the life history of Apioceridae (1947).

49. APIOCERA ASILOIDES, sp. nov. ♂, ♀

From *A. asilica* group, but on account of its small size it is more practicable to include it in *A. brevicornis* group.

From the species of the *A. asilica* group it is easily distinguishable by the haired bottom of mouth cavity in both sexes; the only other species with such hairs is *A. pilosoris.*

Male

A very narrow vertex is highly typical of this species, but there are 2 forms, to which definite taxonomic status cannot yet be assigned: the 1st (typical) has a vertex about 1/7 of head with, and the anterior ocellus occupying 1/3 of frons width at its level; the 2nd one has a vertex a little broader, occupying about 1/6 of head width; anterior ocellus occupying a little less than 1/3 of frons width on the same level. From the frons to the base of antennae covered with brownish, erect hairs. Antennae as in *A. albanyana*. Palpi yellow, with yellowish hairs, the apical joint distinctly broader than the basal one, but only slightly curved.

Pattern of mesonotum not very well developed. Sides of thorax with long and dense white hairs, but on mesopleurae there is a tuft of brown hairs.

Proportion of body closer to *A. asilica*: thorax broader than in *A. brevicornis* group; abdomen in male with abruptly narrowed apical ½. On basal tergites hairs are long and dense, as in typical species of *A. asilica* group. Pattern of abdomen similar to that of *A. moerens,* but whitish triangles are less developed.

Comparatively short and narrow labella and yellow legs separate this species easily from *A. asilica* and *A. moerens.*

Female

Similar to male, but vertex occupying about 1/3 of head width. Pattern of abdomen not as well developed as in *A. asilica* or *A. moerens*, being more reminiscent of that of *A. brevicornis.*

Length of body 16-20 mm, of wing 11 mm.

WESTERN AUSTRALIA: 10 ♂♂, 7 ♀♀, 24, 27.i.1937, White Lakes (K. R. Norris); 1 ♀, 23.xi.1938, Coolup (K. R. Norris); 2 ♂♂, 2.i.1941, Capel (P. N. Forte), var. Type in Division of Entomology Museum, C.S.I.R.O., Canberra.

"Specimens of this species were taken visiting the flowers of the Rottnest Island daisy *Trachymene coerulea*) at the side of the southern lake of the two. Males and females seemed to be equally abundant. In visiting the flowers the flies vary somewhat in behaviour. Some buzz quietly from flower to flower like a bee, others take a trip into one flower, then fly along way off at high speed. Whilst traversing a bloom the flies kept the wings in rapid vibration. One specimen watched at very close range prodded its proboscis into many separate florets of the one flowerhead as it walked over it. Characteristically the end of the abdomen is jauntily upcurved in both sexes whilst feeding or resting (this character is often preserved in pinned insects also—S.P.).

Occasional specimens were seen or taken resting on the ground, usually in open spaces. Sometimes very active specimens, which do not seem to show any interest in the flowers, "take possession" of an area, and appear to defend it actively against other insects, particularly their own species. In one such instance over a patch of about a square yard of bare soil, male specimens were frequently seen hovering, and indulging in violent aerial tussles. In two other cases a male fly was seen to perch alertly on the twig of a dead shrub over a dense growth of daisies. Every now and again the male would dart off into the air, sometimes for no apparent reason, sometimes to investigate a passing insect (on one occasion a large bombyliid). Then it would return to its twig. On such flights the noise produced is shrill and powerful." (Norris, personal communication).

50. APIOCERA BIGOTI Macquart ♂

Macquart, 1847, Dipt. Exot. Suppl. 2: 49.

Macquart writes:

"Supra nigricans. Thorace quinque vittis albidis. Abdomine bifariam albo maculato; subtus alba. (Tab. 2, fig. 1.)

Long. 8 l. ♂. Trompe noire. Palpes d'un jaune terne, à poils blancs. Face blanche. Front d'un blanc un peu jaunâtre, à petits poils noirs; une petite tache noirâtre à la base; une autre vers le milieu; vertex gris. Antennes noires; premier article à duvet gris et poils noirs. Abdomen: les taches blanches appuyées au bord postérieur des deuxième, troisième, quatrième, et cinquième segments, arrondies en-dessus. Pieds noirs. Balanciers bruns. Ailes trés-hyalines.

De la Tasmanie. M. Bigot."

Macquart's Figure 1 shows an *Apiocera* of *A. asilica* group (probably nearer to *A. brevicornis*) with 4 pairs of whitish markings on 2nd to 4th tergites; the apices of the markings are rounded, as mentioned also in the text. The remainder of the tergites is black. Scutellum black, with narrow whitish margin. On anterior ½ of mesonotum, which is brown, there are 5 whitish longitudinal stripes, posterior ½ of mesonotum is nearly black, without stripes (probably rubbed). Venation of *A. asilica*. Proboscis short, nearly as long as antennae. Labella is very large, representing the whole proboscis. Antennae and palpi of *A. asilica* type.

Among the very rich material in the hands of the author, representing the most important museums in Australia, no *Apiocera* from Tasmania was represented. This species was described from Tasmania, and the author believes that there are apiocerids on this island. The synonymization of this species with any Australian species the author regards as premature. Tasmanian collections are very meagre and there has been little recent collecting in that State. A decision in regard to this species can only be made by further collection of Tasmanian flies.

XII. *Apiocera asilica* group

This group consists of the 12 following species: *A. asilica* Westw., *A. moerens* Westw., *A. swani*, sp. nov., *A. basivillosa*, sp. nov., *A. antennata*, sp. nov., *A. septentrionalis*, sp. nov., *A. ornata*, sp. nov., *A. orientalis*, sp. nov., *A. pica*, sp. nov., *A. commoni*, sp. nov., *A. fasciata*, sp. nov., and *A. pilosoris*, sp. nov.

Some, such as *A. pica* or *A. commoni*, sp. nov., are very distinct, but most are grouped around *A. asilica*.

For this group the presence of 5-6 strong bristles at hind margin of scutellum is typical, whilst in other groups there are only 4. Dense and long hairs on the under side of the thorax and on the basal segments of the abdomen are also characteristic for this group but not all species have this character.

In the males of all species the vertex is very narrow, never broader than ¼ of the head width. The venation is always very well developed, without obsolete or very weak veins.

51. APIOCERA ASILICA Westwood ♂, ♀ (generotype)

Westwood, 1835, Phil. Mag. **6**: 449.

The solution of the identity of *A. asilica* is very difficult. Westwood's diagnosis (1835) is too short: "Nigra; vertice, thoracis lateribus piceis; palpis albidis; alarum nervis nigris. Long. corp. lin. 9½, exp. alar. lin. 17. Hab. in Nova Hollandia."

In 1841 he repeated this description adding "fem." In the same paper he described another species: *A. fuscicollis*: "Obscure fuscus; thorace cinereo subvittato; palpis albidis; alarum nervis internis pallidis; corpore subtus albido villoso. An varietas praecendentis? exp. alar. lin. 17. Hab. Nova Hollandia."

It is evident that Westwood was in doubt about the validity of his *A. fuscicollis*. In the same paper (1841) he described a 3rd species of this group under the name *A. moerens* as follows: "Obscure nigra, facie corporeque subtus pilis cinereo-albis valde obsitis, thorace vitta angusta media aliisque tribus utrinque in medio disci abbreviatis cinereo-albis, abdominis segmentis 2, 3, et 4 lateribus et maculis duabus triangularibus ad marginem posticum magnitudine descrescentibus, 5 toque maculis duobus basalibus, cinereo-albis, alis hyalinis, venis nigris. ♀. Long. corp. lin. 10. Expans. alar. lin. 14. Habitat in Nova Hollandia. Mus. Newman."

To this description he adds a beautiful coloured figure (Plate 14, Fig. 6), which shows us that *A. moerens* is a species from the *asilica* group.

It is noteworthy that although in the text the sex is given as female, the figure represents without any doubt a male.

To the description of *A. moerens, asilica,* and *fuscicollis* he adds: "I am by no means satisfied of the specific diversity of these three insects; my specimen of *A. asilica* being in a very mutilated state."

In 1940, G. H. Hardy made an attempt to clarify this question. He wrote: "A letter from Dr. B. M. Hobby (which includes the view also accepted by Mr. H. Oldroyd) states that the types of the two first species of Westwood are in the Hope Museum, but recognised as being the types in Sir Edward Poulton's handwriting. The type of *A. moerens* is apparently lost and so specimens regarded as conspecific were used for comparison. The two types have lost nearly all their pulverulent overlay and are more or less uniform dull-black; only a remnant of the abdomen remains in *fuscicollis.* Size, shape, antennae and mouth parts, and faint tracings of markings follow closely those of *moerens,* so it is advisable to regard all three as belonging to one valid species. The only difference detected is in the light wing veins on *fuscicollis.*"

The author thinks that to solve this problem it is necessary to select a new type for *A. asilica* Westw. because:

(1) The descriptions of *A. asilica* and *A. fuscicollis* are too short for recognition of the 2 species.

(2) Types of both species are in a condition unsuitable for recognition and redescription.

(3) Westwood himself was in doubt as to their diversity.

(4) The description of *A. moerens* and the figure are sufficient for recognition of the species, but the type is apparently lost and the species belongs to the group in which there are very closely related species. Moreover, Westwood himself was in doubt as to its specific diversity.

For neotypical species the author proposes to take one of the commonest and most widely distributed species of the *A. asilica* group. A series in good preservation was collected by Dr. A. J. Nicholson in the Blue Mountains. The neotype is preserved in the Division of Entomology Museum, C.S.I.R.O., Canberra.

The species has the following characters in the male:

(1) Vertex very narrow, occupying approximately 1/7 of head width; distance between posterior ocellus and eye at most as large as the width of the ocellus; ocellar triangle very elongated, at least twice as long as its width; frons usually black haired, with a black tuft below the anterior ocellus.

(2) Proboscis in normal position (not being extruded) very short, reaching only to apex of 3rd antennal joint or slightly further; labellum fleshy, broad, and long; its length about as great as distance between base of antennae and anterior ocellus; at most twice as broad as 1st antennal joint, and distinctly broader than last joint of palpi; basal part of proboscis also very broad.

(3) Palpi slightly curved, boomerang-like; the last joint is broad, broader than 1st basal joint of antennae, at tip obtuse, usually with many strong black bristles, but there are specimens (not typical) with white ones.

(4) Antennae not very long, approximately as long as horizontal diameter of head; 1st basal joint thick, at apex broader; 2nd joint round, but a little depressed in longitudinal axis; both basal joints as a rule with long and strong black bristles; 3rd joint elongated pear-like, a little longer than the 1st joint, and a little narrower, with a very distinct style.

(5) Face with a distinct bow-like furrow, narrow, narrower than labella, at epistoma nearly bare.

(6) Mesonotum in well-preserved specimens with well-developed greyish stripes on brown ground, but they are not very contrasting with the brownish ground; the greyish markings on posterior ½ difficult to distinguish.

(7) Three dark brown markings on the 2nd and 3rd tergites reaching the hind margin; viewed from the side the brown spots at the sternite line of the 2nd and 3rd tergites are connected or nearly connected with the lateral brown markings visible from above.

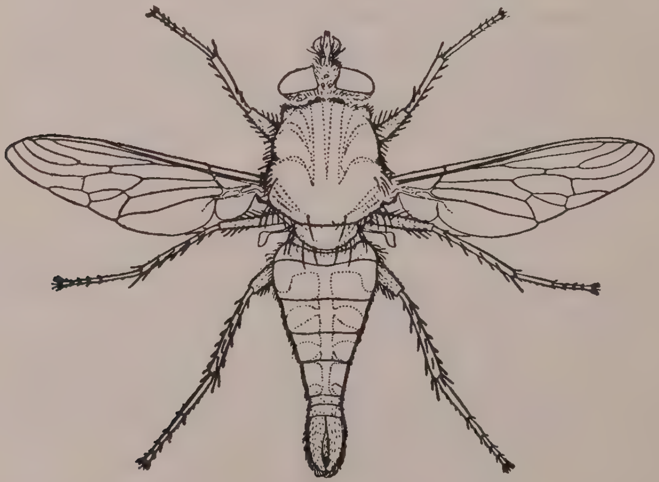

Fig. 5.—*Apiocera moerens* ♂. × 2.5.

(8) As a rule all coxae have numerous black bristles.

NEW SOUTH WALES: 1 ♂, 11.xii.1923, Berowra (T. G. Campbell); 1 ♂, 31.i.1926, Port Hacking, near Sydney (A. Musgrave) and 2 ♂♂, 31.i.1925 (T. G. Campbell). QUEENSLAND: 1 ♂, 3.xii.1912, Stradbroke I. (H. Hacker); 1 ♂, 11.xii.1915, Brisbane (H. Hacker). VICTORIA: 1 ♂, Kewell. WESTERN AUSTRALIA: 1 ♀, 28.xii.1947, Bullsbrook (D. C. Swan). SOUTH AUSTRALIA: 7 ♀♀, 9.iii.1948, Hartley (D. C. Swan).

52. APIOCERA MOERENS Westwood ♂, ♀

Westwood, 1841, Arcana Ent. 1: 55, tab. XIV, fig. 6.

The type of *A. moerens* is apparently lost, and we have only a coloured figure of this species. The very contrasting marking of the body leads us to accept as *A. moerens* one of many forms grouping around *A. asilica* (Fig. 5).

The author has taken one of the well-preserved males as a neotype. This species is very closely related to *A. asilica,* the characters of the male are:

(1) Vertex a little broader than in *A. asilica,* occupying approximately 1/6 of head width; distance between eye and ocellar triangle as great as breadth of ocellus; ocellar triangle elongated, but shorter than in *A. asilica;* frons as in *A. asilica.*

(2) Proboscis, antennae, palpi, face as in *A. asilica,* but the palpi have only long whitish hairs, no strong black bristles.

(3) Mesonotum with very contrasting yellowish grey stripes and spots, which are well developed also on the posterior ½.

(4) The dark spots at sternite line of 2nd, 3rd, and 4th tergites (viewed from the side) are distinctly and broadly separated from the dark lateral spots viewed from above; these lateral dark markings do not touch the hind margins of the tergites.

QUEENSLAND: 1 ♂, 2.xi.1924, Brisbane (Goldfinch); 1 ♂, Gayndah (Masters). Neotype in Division of Entomology Museum, C.S.I.R O., Canberra.

53. APIOCERA SWANI, sp. nov. ♂, ♀

Most conveniently associated with the *A. asilica* group, but actually a link between this and the *A. hardyi* group, having the striping of the mesonotum as in the last group.

Male

Vertex occupying a little less than 1/5 of head width; distance between eye and posterior ocellus nearly twice as great as width of ocellus. Frons and face white pollinose, with a not very well-marked brownish stripe in the middle of frons. Hairs on ocellar triangle and frons brown. Antennae as in *A. asilica* group, 3rd joint pear-like, antennae brown, with long black bristles. Palpi yellow, boomerang-like, rounded at apex, yellowish haired. Proboscis black, distinctly protruding beyond apex of antennae; labella long, nearly as long as 2nd joint of palpi, narrow, a little broader than basal part of proboscis. Occipital bristles yellowish.

Mesonotum with very contrasting longitudinal yellowish and brown stripes; similar to that of the *A. hardyi* group. There are 9 stripes: 2 whitish lateral, which are as broad as the 2 brown sublateral, the 2 sublateral stripes have a cigar-like shape, and on the level of humeral calli separated by a narrow yellowish cross band; mesad of these stripes there are 2 yellowish and slightly narrower stripes, and the median part is occupied by 2 brown, parallel-sided stripes joined in front of scutellum, they are separated by a yellowish stripe of 1/3 of the width, which disappears on the last 1/3 of mesonotum. Scutellum brown, with broad yellow lateral margins. The hairs on mesonotum not very long or dense. Under side of thorax white, and white haired. Halteres yellow. Wings quite hyaline. Legs brown-yellow.

Abdomen having the shape typical of that of the *A. asilica* group. Ground colour black, with very sharply marked white triangles on 6 basal segments; remainder of abdomen dark. These triangles are very long, their apices reaching the anterior margin, except on the 2nd tergite. These triangles tend to form a white longitudinal stripe, but the black median and lateral markings are distinctly separate, not tending to form dark parallel-sided stripes. The lateral dark markings are not oblique as in *A. asilica* etc.

Female

Only 1 damaged female is available for description. It is similar to the male, but the vertex occupies a little more than 1/3 of the head width; ocellar triangle occupying 1/3 of vertex width.

Frons mostly yellowish. Mesonotum as in male. Abdomen greasy (in available specimen). Only the last tergite with the erect black hairs.

Length of body 19 mm, of wing 12 mm.

1 ♂, 1 ♀, 28.xii.1947, Bullsbrook, W.A. (D. C. Swan), "on flowering shrubs."

Type in the Division of Entomology Museum, C.S.I.R.O., Canberra. This species is named in honour of Mr. D. C. Swan, Entomologist of the Waite Agricultural Research Institute, Adelaide.

An additional female specimen from Bullsbrook, W.A., not as greasy as the typical, shows the following details: the dark median stripe of abdomen is nearly parallel-sided; the whitish sublateral markings are not triangular as in male, but narrow, "blacket"-like; on 5th tergite on anterior ½, no dark lateral spots.

54. APIOCERA BASIVILLOSA, sp. nov. ♂

Closely related to *A. swani*, sp. nov., but differs in having very long and dense white hairs on the 1st and 2nd tergites and short white markings, which are not developed longitudinally as in *A. swani*, but transversely.

Head proportions in general as in *A. asilica*, antennae in size, shape, and proportion of joints as in *A. asilica;* proboscis a little longer, palpi narrower. Vertex comparatively broad, occupying ¼ of head width, a little broader than the whole ocellar triangle. On face and along the epostoma hairs rather numerous. Frons with brown median stripe, and numerous similarly coloured hairs; bare in front of bases of antennae. At the level of base of proboscis the eyes are separated by a distance distinctly more than 1/3 of head width.

Mesonotum with well-developed striping. The broad sublateral brown stripes are of irregular form and separated into 3 spots by 2 whitish cross bands. Brownish hairs on mesonotum dense and comparatively long, especially in front of scutellum. Wings hyaline, venation normal. Halteres yellow. Femora black, tibiae and tarsi yellow. Under side of thorax, with very long and dense white hairs. Coxae with black bristles.

Abdomen of *A. asilica* shape—narrowing very abruptly in the apical ½. The white triangular markings on the 1st, 2nd, and 3rd tergites are nearly equilateral, comparatively small, on the 1st tergite occupying nearly the whole length of segment, on the 2nd and 3rd tergites only the apical ½ of their length. The dark spots at sternite line are large, touching the sternite and almost joining the lateral dark markings. First and 2nd tergite and the basal ½ of the 3rd tergite with very dense and long white hairs. Fourth tergite with 2 pairs of small whitish triangles, 1 pair at anterior, another at posterior margins. Fifth tergite predominantly white; the remainder of the abdomen and genitalia dark brown.

Genitalia of *A. asilica* type.

Length of body 20-21 mm, of wing 11.5-12 mm.

SOUTH AUSTRALIA: 2 ♂♂, Dec. 1934, Aldinga (J. S. Womersley); 1 ♂, 1941, Mt. Gambier (J. S. Womersley); 1 ♂, 11.i.1950, Tooperang (D. C. Swan). Type (male) in the South Australian Museum, Adelaide; paratype in the Division of Entomology Museum, C.S.I.R.O., Canberra.

55. APIOCERA ANTENNATA, sp. nov. ♀

Closely related to *A. orientalis*, sp. nov., but differs from all other species of *Apiocera* by its extremely long antennae and the shape of the 3rd antennal joint.

The description is based on 1 very old specimen, the colour of which has probably lost its normal intensity, but which is well preserved in other regards.

Antennae are longer than the head. Third joint fusiform, twice as long as the 2 basal joints together, 2nd joint very small, spherical, 1st joint thick, short, on inner side 3 times, on outer side twice as long as the 2nd. Antennal bristles yellowish. Proboscis not reaching the apex of antennae. Labella large, distinctly broader than proboscis. Palpi as in *A. asilica*, broad, yellowish haired. Face bare, comparatively long, a little longer than ocellar triangle, without a bow-shaped furrow at base of antennae.

Vertex much broader than 1/3 of head width, and a little more than 3 times broader than ocellar triangle.

Ocellar triangle short, not elongated, nearly equilateral, distance from anterior ocellus to base of antennae nearly twice as long as the ocellar triangle. Frons with short hairs, without dark markings, slightly yellowish. Occipital bristles black.

Ground colour of mesonotum seems to be more brownish than black (the specimen is very old). Striping not very well developed. Hairs short and sparse. Sides of thorax sparsely haired. Bristles on mesonotum and scutellum black, on coxae yellowish. Wings hyaline, with yellow veins. The vein m_{3+4} ½ as long as the vein at the apex of subdiscal cell. Axillary cell very broad. Halteres yellow. Legs brown.

Abdomen not long, conical. Ground colour brown. The usually whitish markings on abdomen are yellowish, and not contrasting with the brown ground colour. On 2nd and 3rd tergites there are pairs of large, equilateral triangular yellowish spots, which nearly reach the anterior margins of the tergites. The markings on the other tergites not readily visible. Only the last tergite with erect black hairs.

Length of body 18 mm, of wing 12.5 mm.

1 ♀, with a label: "S. Austr." Type in the Division of Entomology Museum, C.S.I.R.O., Canberra.

There are also 3 ♀♀ from Mataranka, N.T., which belong probably to this species. They are a little darker, with more marked striping on mesonotum. The very broad sublateral brown stripe is irregular and separated into 3-4 spots. Surface of the wing is slightly yellowish.

56. APIOCERA SEPTENTRIONALIS, sp. nov. ♀

Closely related to *A. antennata*, sp. nov., but differing markedly in structure of antennae.

Antennae as long as head. Third joint cigar-like, as long as 2 basal joints together, 1st joint as broad as the 3rd, not oblique as in *A. antennata*, 3 times longer than the 2nd joint. Proboscis narrow, long, protruding far beyond the apex of antennae; labella as narrow as proboscis, short, as long as the 3rd antennal joint. Palpi much narrower than in *A. antennata*. Face as in *A. antennata*. Vertex narrower, scarcely 3 times as broad as the ocellar triangle, occupying 1/3 of head width. Ocellar triangle a little longer than in *A. antennata*.

Thorax as in *A. antennata*, but with very well-marked striping of the anterior ½. The median yellowish and 2 brown submedian stripes of equal width. Sublateral broad brown stripe irregular, separated into 3 spots by cross bands. Wings as in *A. antennata*, but the vein m_{3+4} as long as the vein at the apex of subdiscal cell.

Abdomen as in *A. antennata*, but the yellowish triangles on 2nd and 3rd tergites are more whitish and lower, the markings on 4th tergite are similar but there is in addition a pair of very small whitish triangles at the anterior margin.

Length of body 18 mm, of wing 12 mm.

1 ♀, Katherine, N.T. (Brown). The condition of preservation as in *A. antennata*. The type locality may be the same.

Type in the Division of Entomology Museum, C.S.I.R.O., Canberra.

57. APIOCERA ORNATA, sp. nov. ♂, ♀

Differs from other species of the *A. asilica* group in its extremely sharply developed markings on the mesonotum and abdomen, and in the bright yellow ground colour of antennae, except the tip of the 3rd joint.

The body is much browner than in *A. asilica*, the light stripes on the mesonotum and the spots on the abdomen are not white, whitish, or greyish, but with a distinctly yellowish nuance.

Ground colour of antennae bright yellow, except for apical ½ of 3rd joint, which is black (character exclusive to this species!). First joint of antennae comparatively longer than in *A. asilica*, and 3rd joint at base is more sharply narrowed. Proboscis in male rather long (the labella extending beyond the tip of antennae), in female shorter (only ½ length of labella extending beyond the antennae), labella in female larger, in general large, fleshy. Palpi distinctly yellow, yellowish haired, not differing from those of *A. asilica.*

Tomentum of frons and particularly occiput bright yellow, nearly golden, on face whitish yellow, on vertex and middle line of frons brown spots. Bristles on occiput and antennae numerous, long, black.

Vertex in male slightly less than 1/6 of head width, in female 1/3 of head width. Frons, particularly in male, with very dense and long brown hairs. Head distinctly narrower than thorax. Proportion of thorax as in *A. asilica.*

In central portion of mesonotum there is 1 broad brown longitudinal stripe extending to the scutellum; this stripe in some specimens of this species (as in *A. asilica*) is divided by a very narrow yellowish line; on either side of this brown stripe there are 2 yellowish, parallel-sided, broad, longitudinal stripes, extending beyond the suture and each connecting with a yellow prescutellar spot. In typical *A. asilica* these stripes are not always parallel-sided and not oblique to the longitudinal axis of thorax (in this relation the new species is similar to *A. brevicornis*). The broad sublateral brown stripes are here very faintly divided with oblique yellowish stripes; lateral yellowish stripes broad. Scutellum yellowish dusted. In other regards not differing from *A. asilica.* Legs (including femora) reddish yellow. Halteres yellow. Wings as in *A. asilica,* but venation on basal ½ yellow.

Abdomen in general as in *A. asilica,* but the yellowish white sublateral spots at sides of 1st, 2nd, and 4th tergites are subequal, having the form of small, nearly equilateral triangles (in *A. asilica* they are mostly elongated in the transverse direction).

Size as in *A. asilica.*

7 ♂♂, 1 ♀ (without locality, but very probably from eastern coast of Australia, between Sydney and Brisbane), all specimens in perfect condition. The types in School of Public Health and Tropical Medicine, Sydney.

N.B.—In general appearance very similar to *A. lugubris,* but the latter species is much darker.

58. APIOCERA ORIENTALIS, sp. nov. ♂, ♀

Very closely related to and probably only a subspecies of *A. fasciata,* but the true systematic position must await the accumulation of data on distribution.

Male

Vertex a little broader than in *A. fasciata,* occupying 1/6 of head width. Hairs on frons, face, and antennae chiefly whitish, only some hairs on ocellar triangle and some bristles on antennae brownish. Third joint of antennae not pear-like, but more ellipsoidal, elongated, it is distinctly longer than 2 basal joints together. Palpi yellow, with whitish hairs; basal joint very narrow, apical joint very broad, 3 times broader at apex than at base, rounded, protruding at least to the apex of 2nd antennal joint. Proboscis protruding only a little further than antennae.

Mesonotum with poorly developed brownish and greyish markings. Central greyish stripe is nearly as broad as 2 brown ones flanking it. A brownish spot reaches back from each humeral callus to the suture. Hairs on mesonotum brownish and whitish, much shorter and paler than in *A. fasciata*. Hairs between notopleural bristles pale. Venation as in *A. fasciata*, but veins mostly yellowish.

Abdomen, as in many species of *A. asilica* group with much longer white hairs on 1st tergite and anterior part of the 2nd. Four basal sternites with extremely long, white, depressed hairs, with apices protruding distinctly beyond the hind margin of sternites; remainder of sternites black-haired. Second, 3rd, and 4th tergites with isolated brown spots in area of sternites (in *A. asilica* these are absent).

Female

Very similar to male. Vertex distinctly broader than 1/3 of head width. Tergites without isolated brown spots at sides. From female of *A. fasciata* it differs in the broader vertex, the presence of pale hairs and bristles on head (bristles on occiput are black), and long whitish hairs on the 4 basal sternites.

Length of body 22 mm, of wing 15 mm.

1 ♂ (sine data), Macleay Museum (type); 3 ♀♀, "N.S.Wales," Macleay Museum, Sydney. Although the male is not labelled, it is very probable that it was collected in New South Wales as were the females; the similarity of the state of preservation, and particularly extremely long, old pins, on which only these four specimens are mounted, favour this view.

59. Apiocera pica Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. **22**: 56.

Norris writes:

"A large stout fly. Body comparatively short in proportion to width.

Male: Head large, about as wide as thorax and covered with a white tomentum. Eyes large, separated at vertex by one-fifth of the head-width. Height of ocellar triangle about two and a half times the base. Ocellar tubercle thickly clothed with long wavy dark brown hairs which extend in two parallel rows to near the bases of the antennae where they are replaced by white hairs.

Antennae fairly short, basal segment stout, brown, with white tomentum; a strong bulge on the lower surface near the distal end; vestiture consisting of a number of black bristles and a few white hairs. Second segment brown, tomentum white; a whorl of about a dozen black bristles round its middle. Terminal segment black, dusted with white, particularly proximally; symmetrical in profile. Style distinct, black.

Palpi longer than antennae, basal segment cylindrical, dark brown in colour; with a few long white hairs below and one or two black bristles. Second segment broad and flattened distally, lighter in colour; truncate apex slightly incised, also with sparse white hairs and one or two black bristles. Palpal pit prominent.

Face very narrow, as antennae are situated close to epistoma. The latter has a small fringe of short white hairs.

Proboscis black, folded labella rounded apically and considerably broader than proboscis in profile.

"Post-optic" bristles well developed, not extending far down posterior margin of eye. These spines are intermingled with white, radially directed hairs which are continued down the sides behind the eyes as a fringe resembling an Elizabethan ruff in appearance. Head capsule, the ground colour of which is black, is thickly beset at base of proboscis and below neck with long white hair.

Proboscis twice the length of antennae, about two and a quarter times the length of head.

Thorax: Pronotum with black bristles and white hairs above. Ground colour of mesonotum black. A band of white pulverulence round periphery, not extending onto scutellum. Anteriorly a median white stripe extends back to about the level of the suture. On either side of this is a more prominent white stripe, broadening anteriorly, where each curves outwards. These also extend to about the level of the suture. Along the line of the suture a white wedge points inward from the marginal band. From the latter two other white wedges arise on each side, one behind and one in front of the suture, curving respectively forwards and backwards to touch the sutural mark between its apex. These three wedge-shaped marks on either side run into the paired longitudinal stripes near the hinder end of the latter. A pair of broad white bars is situated in front of the scutellum and behind the terminations of the vittae; from each of these marks a thin white line extends outwards and forwards to meet the apex of the sutural wedge. A small median white spot is situated in front of the scutellum. The latter is black and has a fringe of white hairs. Areas between the white marks are brownish to blackish in colour. The whole of the mesonotum, excepting the space occupied by the white fringe on scutellum, is beset with a thick coating of brown hairs. Post-alar callus with a dense tuft of white hairs.

Pleura dark brown, with a white tomentum and a dense coating of white hairs which are also particularly abundant on prosternum. Pteropleuron with a patch of black hairs.

Legs long, brown; but so densely black-haired as to appear black. Coxae with white hairs, white tomentum and some black bristles.

Wings hyaline, normal.

Abdomen: Marked with black and white pattern. Ground colour dark brown. Basal tergite mostly sooty black, but laterally white and with two white spots posteriorly. The second tergite bears the largest dorsal white markings in the form of two broad, transverse white strips. These marks are separated by a median black band and this broadens over the anterior half of the tergite and laterally sweeps back to the posterior corner of the tergite. Anterior corners white. Third tergite mostly black; two white marks posteriorly, and antero-lateral corners white. Fifth tergite mostly white; black central stripe and posterior edge. Remaining tergites black or brownish. Venter white. Abdomen covered with short black bristles. Basal tergite with dense white hairs and two lateral patches of black hairs. One or two following tergites and the anterior sternites have a few white hairs.

Terminalia dark brown with a thin coating of white tomentum and with a covering of short black bristles. The terminalia of this fly are of a non-descript type which is found in the majority of species and shows no very definite external differences for specific diagnosis. The whole terminalia in the resting condition fit closely together like a box, leaving only a small opening on the dorsum, where the proctiger protrudes. The clasper is distinctive (Plate 2,a).

Female: Similar to male, except that the eyes are more widely separated, being one-third of the head-width apart.

Measurements: Male, body 18.5 mm., wing 14 mm. Female, body 18.5 mm., wing 14 mm.

Hab.: Gnangara, W.A., 1 male, November, 1930; 2 females, December, 1930, Perry. Gnangara, W.A., November, 1930, 2 males, 1 female, O'Connor. 2 females, 1 male unlabelled."

To the detailed description of K. R. Norris the following remarks may be added: This species belongs to the group of *A. asilica*, but may be separated easily by the white markings of the abdomen and the armature of last 2 segments of the abdomen in female.

The lateral white spots on the 1st tergite are smaller and more rounded than in *A. asilica*; the 2nd tergite has a black regular marking in the form of the very broad and short "tailed" letter "T" (in *A. asilica* the "tail" is not parallel-sided and the "head" of the letter is not straight, but in the form of a broad arrow). In the female the last 2 segments are covered above and below with black, dense, erect hairs directed slightly towards the base of the abdomen (in other species of *A. asilica* group only the 7th segment is covered with such hairs).

From under side the insect has a distinctly brownish tinge, while *A. asilica* is whitish below.

The author has seen: paratypes (male and female); Western Australia: 2 ♀♀ (W.A. Dept. Agric.); 2 ♀♀, 24.xii.1947, Bullsbrook (A. Burns); 2 ♀♀, Dec. 1934, Pinjarra (D. C. Swan); 1 ♂, 1 ♀ (Newman); 1 ♀, King George Sound (Macleay Museum, Sydney).

60. APIOCERA COMMONI, sp. nov. ♂, ♀

Very similar structurally to *A. asilica*, but differing in having large snowy white spots on the 1st and 2nd tergites; white is the dominant colour on these tergites, a very small dark spot in the middle and a pair laterally. Light stripes are developed only on anterior 1/3 of mesonotum.

Structure of head and its appendages very similar to those of *A. asilica*, but bristles on antennae mostly white and palpi white haired without admixture of black hairs. Frons white dusted, the brown spots smaller and not so dark.

Mesonotum dark, the white markings are developed only in anterior 1/3 of its length, no longitudinal light stripes extending to the hind margin of mesonotum (even in perfectly preserved specimens). Hairs on mesonotum very dark, nearly black, much darker than in closely related species in which they are brown or dark brown; they are also short, shorter than in *A. asilica*, and equal in length from anterior to posterior end of mesonotum. Dense hairs of notopleural area also black, strongly contrasting with white hairs on the sides of thorax. On the sides of thorax only a tuft on mesopleurae below the base of wing is dark. Bristles on coxae as a rule white. Legs black. Halteres are nearly black. Venation similar to that of *A. asilica* but the veins darker in colour.

First tergite white, with small dark median and 2 lateral spots; 2nd tergite also white, the median dark spot very narrow; in most specimens absent, the small lateral dark spots not oblique as in most species of the *A. asilica* group, but parallel to the median spot. Very poorly developed white markings on 3rd and 4th tergites, remainder of abdomen nearly black.

Genitalia of male seem to be shorter than those of *A. asilica*. Female in genitalia not differing from those of *A. asilica*.

Length of body 22-23 mm, of wing 15-16 mm.

3 ♂♂, 2 ♀♀, 13.i.1949, Rockhampton, Queensland (I. F. B. Common). "Specimens observed flying rather erratically upwards on western side of Eucalypt tree in late afternoon. Periodically they settled on the tree trunks where pairs were occasionally observed in copulation."

The types in the Division of Entomology Museum, C.S.I.R.O., Canberra.

The author has named this beautiful fly in honour of the collector, Mr. I. F. B. Common, to whom he is indebted for many interesting specimens.

61. Apiocera fasciata, sp. nov. ♂, ♀

A representative of a new group (or subgroup of *A. asilica*), which differs in the pattern on abdomen.

Male

Vertex occupying approximately 1/7 of head width. Ocellar triangle very long, distance between eye and posterior ocellus equal to breadth of ocellus. Hairs on entire frons brownish; below ocellar triangle a brown spot or median narrow stripe. Antennae short, brown; 3rd antennal joint elongated, pear-like; 2 basal joints with numerous black bristles. Proboscis protruding a little beyond the apex of antennae, with large labella; palpi with black hairs, on basal joint there are several black bristles. Occiput with numerous fine yellowish white bristles and some strong black bristles.

Mesonotum usually uniformly greyish yellow dusted, without well-marked brown or greyish stripes, but as a rule 1 brown hook-like spot is present at humeral callus. Dark brown hairs are very numerous, longer than in *A. orientalis*, masking the ground colour. Among notopleural bristles there are brown hairs forming 1 extremely narrow stripe. Scutellum usually with 6 bristles. Mesopleurae with very numerous dark, but extremely fine hairs. Legs dark. Halteres yellow. Wings quite hyaline; alula very large. Venation normal, as in *A. asilica*.

Abdomen very elongated, but broad at base. Markings on tergites very characteristic. Rounded dark brown spots absent on sides of 2nd to 4th tergites (in *A. asilica* always present). Markings on 2nd and 3rd tergites are very similar: centrally there is a longitudinal dark spot, extending from anterior margin for 2/3 of the length of the tergites and not reaching the hind margin (in *A. asilica* always reaching it). There are also on each side 2 short, dark cross bands, nearly parallel to anterior margins of tergites (only slightly oblique) (in *A. asilica* they are distinctly oblique and almost reaching the posterior margin of the tergites). These bands only just touch the median spot (in *A. asilica* broadly confluent and broadly reaching the anterior margin of tergites). Fourth and 5th tergites greyish white on anterior ½, with a very small median dark spot, and dark brown on posterior ½ (in *A. asilica* there is on posterior margin a pair of small white spots). All sternites partly or mostly black haired. The colour of the pale spots and bands is very characteristic; they are not whitish as in *A. asilica*, but greyish yellow, and the whole fly has a dark appearance.

Female

Similar to male, but vertex is broader, occupying a little less than 1/3 of head width, abdomen is also broader. Only 7th segment is covered with erect, dense, black hairs. Dark cross bands on 2nd and 3rd tergites are broader and more confluent.

Length of body 28 mm, of wing 15 mm.

WESTERN AUSTRALIA: 1 ♂, 18.xii.1908 (type), 1 ♂, 6.viii.1909, 1 ♂, 28.ii., 1 ♂, 28.viii.1909, 1 ♂, 1 ♀, 7.iii.1911, all specimens from Waroona (L. J. Newman); 2 ♀♀, 60 miles from Perth. Type in the Division of Entomology Museum, C.S.I.R.O., Canberra.

62. APIOCERA PILOSORIS, sp. nov. ♂, ♀

Differing from other members of the *A. asilica* group in the presence of long, dense hair in the mouth cavity. Distinguishable from *A. asiloides* by its bigger size, broader frons in male, structure of palpi, etc.

Vertex in male as in above-mentioned variety of *A. asiloides*, sp. nov. Apical joint of palpi on under side distinctly curved, whilst in *A. asiloides* it is nearly straight, 3 times broader in its apical part than at base (in *A. asiloides* only twice as broad). Bottom of mouth cavity with long and comparatively dense, light hairs.

Mesonotum with distinct markings on anterior part. Brownish hairs well represented on notopleural area. Brown tuft on mesopleurae very dense. Scutellum blackish haired, only margin slightly whitish. Legs mostly black.

Abdomen with well-marked greyish triangles typical for this group.

Female

Similar to the male, but as a rule larger; vertex a little larger than 1/3 of head width.

Length of body 21-30 mm, of wing 11-15 mm.

WESTERN AUSTRALIA: 3 ♂♂, 3 ♀♀, 2.i.1941, Capel (P. N. Forte); 1 ♂, Mt. Jackson; 1 ♂, Mogumber. Type (male) in Department of Agriculture, Perth, W.A., paratype in Division of Entomology Museum, C.S.I.R.O., Canberra.

Genus NEORHAPHIOMYDAS* Norris

Norris, 1936, J. Roy. Soc. W. Aust. 22: 64.

Head much narrower than thorax, which in turn is narrower than abdomen. Head small, occupied by large eyes; viewed in profile the frons is invisible, occiput, cheeks, face, and "chin" appearing as very narrow stripes. Proboscis long, at least 3 times longer than head; labella comparatively very short, as broad as proboscis. Palpi 1-jointed, short. Mouth cavity reaching nearly to base of antennae, very broad, but shallow, separated from the extremely narrow parafacialia by deep furrows; in the middle the cavity has 2 sclerotized, narrow plates, convergent towards the apex, which bear in some species (especially in *N. pallida*, sp. nov., and *N. setosa*, sp. nov.) very long downwardly directed hairs. Antennae as long as head, 3-jointed, style extremely small. First joint cylindrical, short, 2-3 times longer than the nearly spherical 2nd joint; both basal joints with hairs, which are not very long; 3rd joint irregularly cigar-like in shape, blunt at both ends; twice as long as and distinctly broader than basal joints. Ocelli present, ocellar triangle very elongated. Vertex in both sexes broad. Face and frons sparsely haired.

Thorax and scutellum nearly bare (♀), or with short hairs (♂), no bristles. Scutellum very small. Metapleurae developed into a high nodule, which may be rounded or have a pointed tip or even a finger-like tubercle at apex.

Venation very distinctive: m_1 and r_5 are confluent a short distance before fusing with r_4; r_{2+3} and r_4 ending on r_1; m_2 curves up and fuses with other veins, making 1 vein r_5 (and sometimes with r_4); free distal part of m_{3+4} present or absent; anal cell closed. The subdiscal cell (M_4) protrudes more towards apex of wing than discal cell, when the distal part of m_{3+4} is lacking (*N. hardyi* Norr., *N. pallida*, sp. nov., *N. pinguis* Norr. ?), or is nearly of the same length, when the apical veins of discal and subdiscal cell form nearly a straight line. Axillary cell (anal lobe) usually very broad, small only in *N. pinguis*. Alula small, or absent.

Legs rather long; hind tibiae in male of some species clubbed; hind femora on under side at apex with 3 bristles or (rarely) with the apical 2/3 covered with many bristles.

Abdomen rather long and broad, especially in females, with distinct incisures, in male with 8, in female with 9 segments, but some of them may be telescoped. Hairs extremely short and abdomen appears bare. Genitalia of male small, mostly retracted, in female with plainly visible black "hooks" of acanthophorites.

Only 6 species are known, all from Western Australia, though probably more exist. Very probably this genus is restricted to the south-western corner of Western Australia. The flies are collected on flowers.

Norris's (1936) data is the only published material on this strange genus.

The generotype is *N. hardyi* Norr.

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* The author prefers the corrected transcription, because the majority of authors accept the name *Mydaidae*.

This genus is very closely related to *Megascelus* Philippi; Norris 1936 compared it with *Rhaphiomidas* O.S. only because it was considered at that time (as a result of a mistake in Kertesz's catalogue) that the genus *Megascelus* was a synonym of *Dolichogaster* Macq., a mydaid genus (Paramonov 1948; Carrera and d'Andretta 1948).

The comparison of the venation figured by Norris (Fig. 1) with that by Carrera (Fig. 11), or Verrall 1909 (Fig. 333) shows that the only difference is that the vein m_{3+4} on Norris's figure is absent, but it is present in other Australian species of this genus. The only basic difference between *Megascelus* and *Neorhaphiomydas* is the structure of the antennae; in *Megascelus* the 3rd antennal joint is at least twice as long as the 2nd basal joints together and twice as broad (Carrera and d'Andretta 1948, Fig. 7); in *Neorhaphiomydas* this joint is not of such extreme breadth or so elongated. Unfortunately the author cannot find from the literature whether or not the "metapleura" are pointed in *Megascelus*.

In *Neorhaphiomydas* there are 2 groups of species: in one the metapleural tubercle is rounded (*N. pinguis* Norr.), in another it has a finger-like protuberance at the apex.

Both these genera afford further striking evidence of the close relationship between the fauna of Western Australia and the south-western part of South America.

Key to Species of the Genus Neorhaphiomydas

1. Length of body 7 mm. Wings hyaline with a milky sheen. Tubercle in front of halteres smoothly rounded and lacking the pointed tip.................. *N. pinguis* Norr. ♂, ♀

Length of body 12-15 mm. Wings distinctly darkened, especially at anterior border, or suffused or nearly hyaline. Tubercle in front of halteres conical, or with a finger-like protuberance at tip....................................2

2 (1). Vein m_{3+4} absent, apical part of subdiscal cell regularly rounded. Hind margin of wing regularly rounded, with only an incision at apex of anal cell. Hind tibiae in male only slightly swollen at tip; in female the last 3 segments with short, fine, but erect and dense hairs. First tergite in both sexes densely grey dusted...3

Vein m_{3+4} always present, if it does not reach the hind margin, there is a short stub of it, and the subdiscal cell is not rounded at the apex, but has a distinct angle towards the hind margin. The hind margin of wing with incisions at the apex of the anal cell and the 4th posterior cell (apex of m_{3+4}). Hind tibiae in male distinctly swollen at apex; in female the last 3 segments of abdomen with a few hairs. First tergite not grey dusted (except in *N. setosa*, sp. nov.)..4

3 (2). Wings distinctly dark-coloured. Vein *r-m* on the middle of discal cell. Femora black....................................*N. hardyi* Norr. ♂, ♀

Wings distinctly yellowish. Vein *r-m* very near the base of discal cell (in its basal ¼). Femora reddish brown.............*N. pallida*, sp. nov. ♂, ♀

4 (2). Males..5

Females..6

5 (4).* Hairs on the vertex, frons, antennae, and face black; bristles on the occiput and on prothoracic collar black. Hairs on mesonotum black, microscopic. Vertex equal to 1/7 of the head width. Hairs on the coxae black, their length normal. Wings dark, with veins which are bordered with more intensely dark colour. . . . *N. norrisi*, sp. nov. ♂

Hairs on the head and the bristles on the occiput and prothoracic collar yellowish. The hairs on mesonotum are yellowish, long. Vertex equal to 1/5 of the head width. Hairs on the coxae yellow, extremely long and dense. Wings yellowish suffused, the veins not bordered with darker colour. . . . . *N. villosa*, sp. nov. ♂

6 (4). Vein *r-m* on the middle of discal cell. More than ½ of the under side of hind femora with black bristles. Mesonotum with 2 distinct broad grey longitudinal stripes; the 1st tergite densely grey dusted. . . . . *N. setosa*, sp. nov. ♀

Vein *r-m* very near the base of discal cell, sometimes the distance is less than the length of vein *r-m*. At apex of hind femora on their under side there are 3 or 4 bristles. Mesonotum slightly grey dusted, without distinct longitudinal stripes; the 1st tergite without dust. 7

7 (6). Wings very dark, with a sharply marked boundary to coloured portion. Third joint of antennae twice as long as the 1st 2 together. . . . *N. norrisi*, sp. nov. ♀

Wings yellowish suffused, no sharply demarcated coloured area. Third antennal joint only 1.5 times longer than the 2 1st joints together. . *N. villosa*, sp. nov. ♀

1. NEORHAPHIOMYDAS HARDYI Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. **22**: 64.

Vertex occupying 2/9 of head width. Antennae black. Basal joint cylindrical, 3rd joint the longest, broadest at middle, tapering somewhat abruptly distad to this, apex rounded in profile; 2nd joint globular. Two basal joints black-haired. Proboscis about 4 times the length. Palpi black, with few yellowish hairs.

Thorax very deep brown. Mesonotum with a coating of very short brown hairs. Two wedge-shaped marks of pale dusting at the anterior end of mesonotum. A small pale patch also appears above the base of each wing. In front of the haltere there is a nodule which consists of a rounded base with a prominent nipple arising from it and projecting backwards. Wings suffused with greyish brown, distally and posteriorly the wing colour is considerably lighter, the courses of the veins being marked by narrow bands of darker colour. The veins m_3 and m_4 form a complete cell with evenly curved boundary, their free portion is absent. The vein *r-m* before the middle of discal cell, but not very near its base.

Legs dark brown, hind femora thickened.

Abdomen stout, not tapering so much distally as in *Apiocera*. Segments 2-5 of same width. Basal tergite reduced, dusted greyish, but anterior edge shiny. Remaining tergites shiny, of a deep brown colour. Posterior edge of tergites 3-6 with a thin white band on either side.

The female broader than the male.

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* The male of *N. setosa*, which is unknown, probably differs from *N. norrisi* and *N. villosa* in the presence of many bristles on the under surface of the hind femora; in both the above-mentioned species there are only 3 bristles at the apex. . . . . *N. setosa*, sp. nov.

Length of body 12 mm, of wing 10 mm.

Western Australia. (Abbreviated from description of Norris.)

The author has seen all specimens studied by K. R. Norris and two additional specimens:

WESTERN AUSTRALIA: 1 ♀, National Park (J. Clark); 1 ♀, 26.xi.1938, Perth (A. J. Turner).

New characters of this species are used in the key for its separation from other species.

2. NEORHAPHIOMYDAS PINGUIS Norris ♂, ♀

Norris, 1936, J. Roy. Soc. W. Aust. 22: 66.

Head similar to that of *N. hardyi*, with greyish white tomentum. Vertex occupying ¼ of head width. Few short white hairs just above antennae. Antennae black; basal joint with straight, parallel edges, 2nd joint broader than the 1st, and shorter than wide. Third joint the longest, fusiform; both basal joints black haired. Face and lateral margins of oral cavity with long, wavy, white hairs. Palpi very small, black. Proboscis about 3½ times as long as head.

Mesonotum with a broad central dark brown stripe, which is bordered on either side by a narrow greyish white stripe broadening anteriorly. The knob which projects in front of base of haltere differs from that of *N. hardyi*, being smoothly rounded and lacking the pointed tip.

Legs dark brown. Posterior femora clubbed, with 4 stout black spines on under side at distal end. Wings hyaline, with a milky sheen. Venation exactly as in *N. hardyi*. No trace of m_{3+4} present. Anal lobe small, alula absent.

Ground colour of abdomen mostly dark brown, segments 3-8 have a pair of creamy white, half-moon-shaped marks at the posterior edges of the tergites, whilst sternites 3-8 have a similarly coloured hind border. Basal tergite greyish dusted.

Female similar to male except that abdomen is broader.

Length of body 7 mm, of wing 5 mm.

Western Australia (Rottnest I., Garden I.). Type in Western Australian Museum. (Abbreviated from description of K. R. Norris.)

3. NEORHAPHIOMYDAS NORRISI, sp. nov. ♂, ♀

With *N. villosa*, sp. nov., this species forms a small group, differing from *N. hardyi* by the characters mentioned in the key.

Male

Head as in *N. hardyi*, but the vertex equals about 1/7 of head width (in *N. hardyi* about 1/6, a little broader); antennae shorter than in *N. hardyi*; the 2nd antennal joint is as long as broad (in *N. hardyi* distinctly elongated), ½ as long as the 1st joint (in *N. hardyi* the 1st joint is 2.5 times longer than 2nd joint); the 3rd joint is twice as long as the 2 1st joints together, rounded at tip, with a few microscopical hairs on the outer side (in *N. hardyi* it is 1.5 times longer than the 2 1st joints, distinctly tapering at the apex, and with distinct hairs on the side).

Thorax as in *N. hardyi*, but the hairs on the mesonotum are so much shorter that it appears bare. The sides of the thorax are covered with a greyish tomentum, but the mesopleurae are quite shining (in *N. hardyi* they are not very shining). Wings as in *N. hardyi*, but paler and the vein m_{3+4} is always present, though it is well developed only in its basal part, the distal part is pale and weak. Where this vein reaches the hind margin of the wing the margin is distinctly, but not deeply, bilobate (as in *Megascelus*). The vein *r-m* is placed very near the base of discal cell, the distance from the base being as long as the vein itself. The cell M_3 is comparatively narrow and smaller than in *N. hardyi*; it is shorter than the discal cell (in *N. hardyi* it is longer), etc.

Halteres yellow as in *N. hardyi*. Legs as in *N. hardyi*, but the hind tibiae are swollen at the apex, twice as broad as at the base (in *N. hardyi* only a little broader than at the base).

Abdomen as in *N. hardyi*, but the 1st tergite is not dusted and the hairs are very short, nearly microscopic (in *N. hardyi* they are particularly long and dense on the sides).

Female

Very similar to the male, but the hind tibiae at tip are only a little thicker than at base, the abdomen a little broader, and the vertex is equal to nearly ¼ of the head width. As in male the veins, which apically close the discal cell and the cell M_3, are straight and running in the same direction, so as sometimes to constitute a single vein. As in male, the acute apical part of the cell M_1 is very short (in *N. hardyi* much longer).

Length of body 12.5-15 mm, of wing 10-12 mm.

WESTERN AUSTRALIA: 4 ♂♂, 22.xi.1938, Coolup (K. R. Norris); 1 ♀, 15.xii.1934, Pinjarra (D. C. Swan). The type (male) in the Division of Entomology Museum, C.S.I.R.O., Canberra.

The single female has very darkened wings, the dark colour is sharply divided from the part along the hind margin of wing. The cell M_2, hind border, and the axillary cell are much lighter than the remainder of wing.

4. NEORHAPHIOMYDAS PALLIDA, sp. nov. ♀

Very similar to the female of *N. hardyi*, but differing by the characters mentioned in the key. The 3rd antennal joint is relatively shorter and the sides of this joint devoid of the black hairs.

Differing from the female of *N. villosa* by the dusted 1st tergite and very narrow and short cell M_3 etc.

3 ♀♀, Wanneroo, W.A. ("36-5566," "36-5568," Western Australian Museum).

The type in the collection of the Western Australian Museum in Perth, paratype in the Division of Entomology Museum, C.S.I.R.O., Canberra.

5. NEORHAPHIOMYDAS VILLOSA, sp. nov. ♂, ♀

Closely allied to *N. norrisi*, sp. nov., but differs by the characters mentioned in the key.

Male

On inner margin of the eyes there are hairs from the posterior ocellus to the anterior (in *N. norrisi* there are 4-5 hairs only near the anterior ocellus).

The ground colour of the body and legs is lighter than in *N. norrisi.*

Female

The vertex is equal to ¼ of head width. The hairs are much longer than in *N. norrisi.* The small bristles on the ocellar triangle and the large bristles on the occiput and prothoracic collar black.

The length of the body and wings as in the other species.

WESTERN AUSTRALIA: 1 ♂, 1 ♀, Midland ("35-3434," "35-3436," Western Australian Museum); 1 ♂, Bullsbrook ("37-3626," Western Australian Museum); 1 ♂, Bullsbrook (D. C. Swan). Type in the Western Australian Museum, paratype in the Division of Entomology Museum, C.S.I.R.O., Canberra.

6. NEORHAPHIOMYDAS SETOSA, sp. nov. ♀

Closely related to *N. norrisi,* sp. nov. It is sufficient to mention only the difference from that species. Head as in *N. norrisi,* but 1st joint of antennae is 3 times longer than 2nd joint (in *N. norrisi* only twice); the 3rd joint is nearly pear-like (in *N. norrisi* more cigar-like with both ends obtuse). Hairs on antennae, face, and in the mouth cavity yellowish, not black as in *N. norrisi.* In this species the hairs in mouth cavity are extremely long.

Thorax as in *N. norrisi,* but the reddish ground colour on under side and on sides of mesonotum, scutellum, and humeral calli is replaced by black. The grey pollinosity which in *N. norrisi* occupies only very narrow lateral stripes and nearly the entire anterior ½ of mesonotum, in this species is replaced by 2 broad lateral stripes and 2 broad submedian stripes; the median stripe of mesonotum is dark. Hairs on mesonotum are yellowish, not dark as in *N. norrisi.*

Wings similar to those of *N. norrisi,* but the suffused wings have no sharp boundary between the dark and nearly hyaline part as in *N. norrisi.* The vein *r-m* is situated on the middle of discal cell, whilst in *N. norrisi* it is situated extremely near the base of the discal cell, at a distance shorter than the length of vein *r-m.* Legs not reddish yellow as in *N. norrisi,* but brown; femora dark brown. The hind femora have on the under side many bristles occupying more than the apical ½, in *N. norrisi* there are only 3 bristles at tip.

Abdomen as in *N. norrisi,* but the 1st tergite densely grey pollinose. The yellow markings are present only on the hind margin of 3rd and 4th tergites; narrow, but broader than in *N. norrisi.*

Length of body 14 mm, of wing 10 mm.

1 ♀, Denmark, W.A. (J. Clark). Type in the Division of Entomology Museum, C.S.I.R.O., Canberra.

VI. ACKNOWLEDGMENTS

The author desires to express his thanks to the following persons for the loan of material and for valuable assistance received in many ways: Mr. R. T. M. Pescott and Mr. A. N. Burns, National Museum, Melbourne; Mr. F. E. Wilson, Melbourne; Dr. A. B. Walkom and Mr. A. Musgrave, Australian Museum, Sydney; Professor E. Ford, Dr. D. J. Lee, and Mr. K. F. Clinton, School of Public Health and Tropical Medicine, Sydney; Mr. J. R. Henry, Macleay Museum, Sydney; the late Mr. T. McCarty and Mr. C. E. Chadwick, Department of Agriculture, Sydney; Mr. G. Mack, Queensland Museum, Brisbane; Mr. J. H. Simmonds, Mr. J. H. Smith, and Mr. H. Jarvis, Queensland Department of Agriculture and Stock; Mr. H. M. Hale and Mr. N. B. Tindale, South Australian Museum, and Mr. D. C. Swan, Waite Agricultural Research Institute, Adelaide; Mr. L. Glauert, Western Australian Museum, and Mr. C. F. H. Jenkins and Mr. P. N. Forte, Western Australian Department of Agriculture, Perth.

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APPENDIX I

The manuscript was quite completed when the author received some apiocerids from Western Australia. Among them he has found 2 new species, the descriptions of which are given below.

63. APIOCERA FLABELLATA, sp. nov.

A. tonnoiri group, but differs from all species of known *Apiocera* by presence of about 7 flabellae (specific broadened spines) on the fore tibiae of male. In the key it runs to alternative with *A. oblonga*, sp. nov. and *A. imminuta* Hardy.

Male

Body extremely narrow, and elongated, slender. Hypopygium very long, at least as long as last 3 segments. Vertex very narrow, occupying at most 1/9 of head width, slightly narrower than ocellar triangle; the lateral ocelli touching the facets. Anterior ocellus very large. Hairs on ocellar triangle, behind, and in front of it, brown. Ocellar triangle 1½ times as long as broad. Frons whitish dusted, with similar hairs in lower ½, sunken. Face is absent because mouth cavity reaches the base of antennae, only very narrow cheeks are present, with white hairs from the base of antennae to the occipital area. The strong split which usually separates the cheeks from the protruding edges of the mouth cavity is here quite absent—a character separating this species easily from all other species. Proboscis short, reaching the basal ½ of 3rd antennal joint, labella large, a little shorter than basal part of proboscis. Palpi yellowish, with whitish hairs. Both joints of palpi nearly equally long, the 1st cylindric, the 2nd dilated, rounded, but its lower corner (apex) is pointed. Antennae brown, 3rd joint yellowish. First antennal joint slightly swollen, as long as the pear-like 3rd one. Both basal joints with whitish bristles, however, at apex of under side and on upper side there are some black bristles on 1st joint, the upper side of the 2nd also with some black bristles at apex.

Occiput whitish dusted, with a row of whitish bristles, but in area of vertex there are also some black ones.

Mesonotum with brownish dust, at sides and at anterior margin whitish dusted. There are 2 more brownish submedian, narrow, longitudinal stripes, but they are poorly developed. Hairs in notopleural area not numerous. Collare with black bristles. Scutellum with brownish dust, and 4 black bristles. Sides of thorax mostly whitish dusted. Wings hyaline, with yellowish veins in basal area. Ambient vein on whole hind margin absent, subdiscal cell much smaller than discal cell. Alula very large. Halteres yellow-brownish. Legs dark brown with more yellowish tibiae and tarsi. On external side of anterior tarsi there are 6 or 7 black, flattened, and dilated spines (flabellae), paddle-like.

Abdomen very long, narrow, 6th segment especially narrow. Ninth segment and hypopygium brown, upper forceps with tufts of whitish hairs at apex. Both forceps nearly equally long. Ninth sternite long, narrow, triangular. Viewed from below the edges of lower forceps are nearly straight, diverging. Hypopygium and 8th sternite sharply contrasting with whitish colour of under side. The membrane at hind margin of 1st to 7th tergites is whitish, broadly darkened in the middle of 1st tergite, with 3 dark spots on 2nd and 3rd, and uniformly whitish on the other tergites. On 2nd, 3rd, and 4th tergites is present a large, brown, nearly equilateral triangle, occupying the whole length of the segment, the sides of the above-mentioned segments with brown longitudinal markings; similar markings are present in the middle of 5th, 6th, and 7th tergites, but the lateral markings on them are poorly developed.

Length of body 19 mm, of wing 9 mm.

1 ♂, Bullsbrook ("48-3211"), Western Australia.

Female

Similar to the male, but vertex much broader, occupying less than 1/3 and more than ¼ of head width; whole frons is brownish haired; 2nd joint of palpi comparatively shorter, shorter than the basal joint; no acute corner on upper side of 2nd palpal joint; the split between the cheeks and mouth cavity is present but not very clearly defined, because face is sunken, and edges of mouth cavity are poorly developed; fore tibiae with usual bristles on external side; abdomen conical, its upper side without well-marked pattern; size slightly smaller.

1 ♀, Bullsbrook, W.A. (probably collected in copula because the label is "42-3212").

The type (male) in the Division of Entomology Museum, C.S.I.R.O., Canberra.

64. Apiocera ordana, sp. nov. ♂

Closely related to *A. latifrons* group, especially to *A. angusta*, sp. nov., but the light brown body colour connects it with *A. omniflava* group.

Main characters of this species can be ascertained from the key, in which this species runs to alternative 34.

Vertex occupying about 1/6 of head width, between the posterior ocellus and eye a distance as broad as 1 ocellus. Ocellar triangle long, about twice as long as broad. On head there are only whitish hairs and yellowish bristles, black ones quite absent. Antennae short, yellow, 3rd joint pear-like, as long as basal 2 joints together. Cheeks extremely narrow, whitish haired. Second joint of palpi rounded at apex, nearly parallel-sided, only slightly curved. Proboscis not reaching the apex of antennae, labella a little shorter than basal part of proboscis.

Mesonotum light brown, with 2 submedian darker longitudinal stripes, extending from anterior margin to scutellum. Scutellum dark brown with yellow margin.

Wings hyaline, veins in basal part yellowish; m_1, m_2, and m_3 weak; alula large. Halteres yellow. Legs predominantly brown.

Abdomen very narrowed in area of 5th to 7th segments, having here only about 1/3 of width at base. Abdomen brownish without well-developed pattern. All hairs on abdomen very short, whitish. Hypopygium well developed.

Length of body 20 mm, of wing 11.5 mm.

1 ♂, "51-16-53," Ord River, W.A. Type in the Western Australian Museum, Perth.

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aliena, sp. nov. ♂	43	XI	508	*maxima*, sp. nov. ♂, ♀	11	IV	480
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